The FOUNDRY

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# Plan Shop with View to Extensions

## Steel Foundry Designed so that Its Present Capacity Can Be More Than Quadrupled with Little Disturbance—Basic Lining Chosen for Electric Furnace —Castings Conveyed in Special Boxes

IF CAREFULLY studied, the organization, equipment and operating system of every foundry indicates the character of the executives which control it. Some foundries operated by large corporations in their entirety will manifest the dominant characteristics of the company of which they are part. The whole organization of the subsidiary will be built along lines similar to the parent company, and the foundry will be equipped to the utmost with labor saving machines or not, according to the policy of the general management. Other foundries are controlled by a single person and manifest the tendencies of his education and training; whether he started from the office, the molding floor or the metallurgical laboratory. However, more recently, broad gage engineers have come into control in designing foundries and are leaving the impress of their training on the industry.

The influence that a trained engineer in active control of a foundry company has in shaping its progress is illustrated in the Dodge Steel Co., Philadelphia. The dominant figure in this company is the president, Kern Dodge, who is a consulting engineer, and his training has made its impression upon the company which he directs. Before this plant was constructed, a careful study was made to determine whether an electric steel foundry would pay in the Philadelphia district and the design was laid out with future expansion as one of the controlling factors. After the plans were made and the building erected, the foundry was equipped with a full complement of machinery and furnaces. The completeness of the equipment will be shown in the detailed description of the plant. The essentials of planning and specifications which are so prominent in the activities

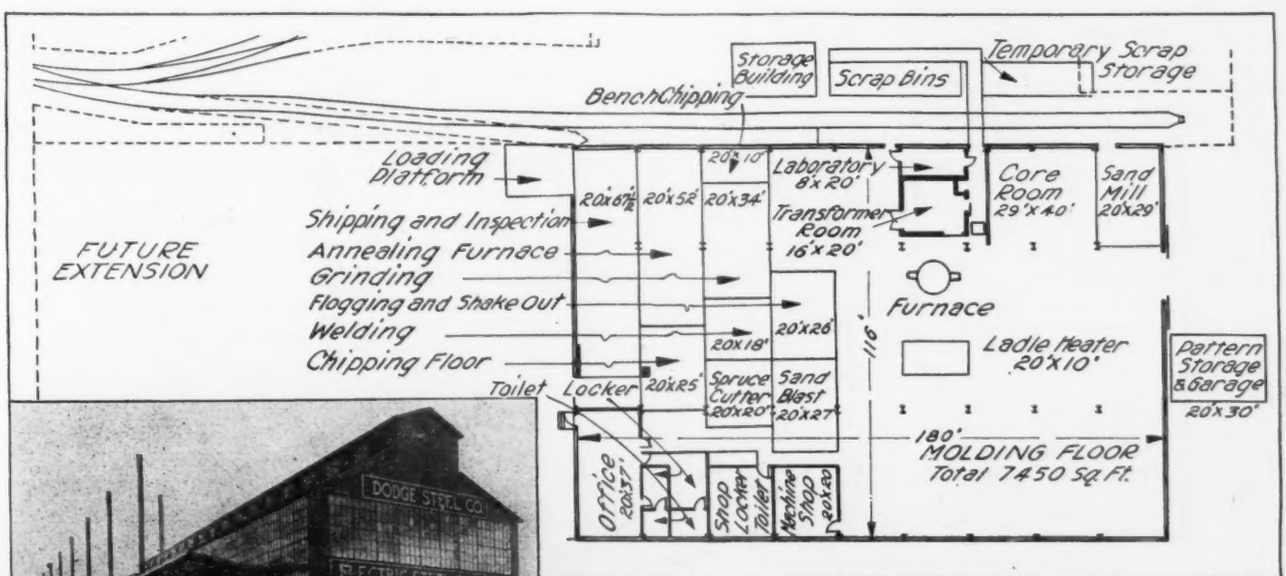


FIG. 1—ONLY A SMALL AMOUNT OF BRICK IS IN THE END WALL TO BE KNOCKED OUT WHEN THE EXTENSION IS ADDED—THE LARGER PORTION OF THE WALL IS GLASS AND SHEET IRON. FIG. 2—THE PORTION OF THE PRESENT LAYOUT CONTAINING THE FURNACE WILL NOT BE CHANGED WHEN THE FIRST EXTENSION IS MADE

of a consulting engineer have made themselves apparent in the insistence on quality in output and the complete planing and cost systems installed.

A survey of the field showed that there was not a single electric furnace working on steel castings in the vicinity of Philadelphia and that a large demand existed for high grade steel castings. Therefore a tract of land was acquired at Tacony, a suburb of Philadelphia, consisting of a rectangular lot of 4½ acres on the south side of State road and a ¾-acre triangular plot on the north side of the same road, abutting on the main line of the Pennsylvania railroad. A siding runs from this line along side of the foundry building which was constructed.

With this amount of land there is plenty of room for future extensions. The story of the company's plans for the coming expansion are told in Figs. 1 to 4. Fig. 1 shows the present structure, which is a combination of two standard designs of the Austin Co., Cleveland. The uprights to the left have been erected for use when the side addition is built. The nature of the construction of the building is such that some expense and trouble was saved by having these columns erected with the first building. The large amount of steel sash window space admits plenty of light to the entire foundry floor.

A plan of the present building is shown in Fig. 2. The lines indicating the different departments are not partitions, but are only used in the illustration to designate the location of the different operations. The only walls or partitions in the room are those for the transformer room and laboratory on the one side, and for the offices and wash and locker rooms on the other. The necessity for keeping all of these departments free from dust dictated the erection of partition walls, but otherwise the foundry is one open space as may be noted in the panoramic view shown in Fig. 3.

The plan of the present building, Fig. 1, shows the electric furnace to be located near the center of the foundry with the molding floor and core room to one side and in front of it. After the molds are poured the castings are carried to the opposite end of the foundry where they are annealed, cleaned, and finished. The shipping and final inspection department is located at this end of the foundry together with the loading platform. The next addition to be built will be erected at the end of the present structure. The furnace is so located that it need not be moved when the first addition is made to the building, but may remain in its original position when it will be in the center of the molding floor. However, all the other equipment will be removed, and a permanent shipping platform will be built. This division, as shown in the lower portion of Fig. 4, then will remain as it is arranged without further changes when additions are made. The increased molding space will require that the furnace be operated day and night to produce enough steel for all molds.

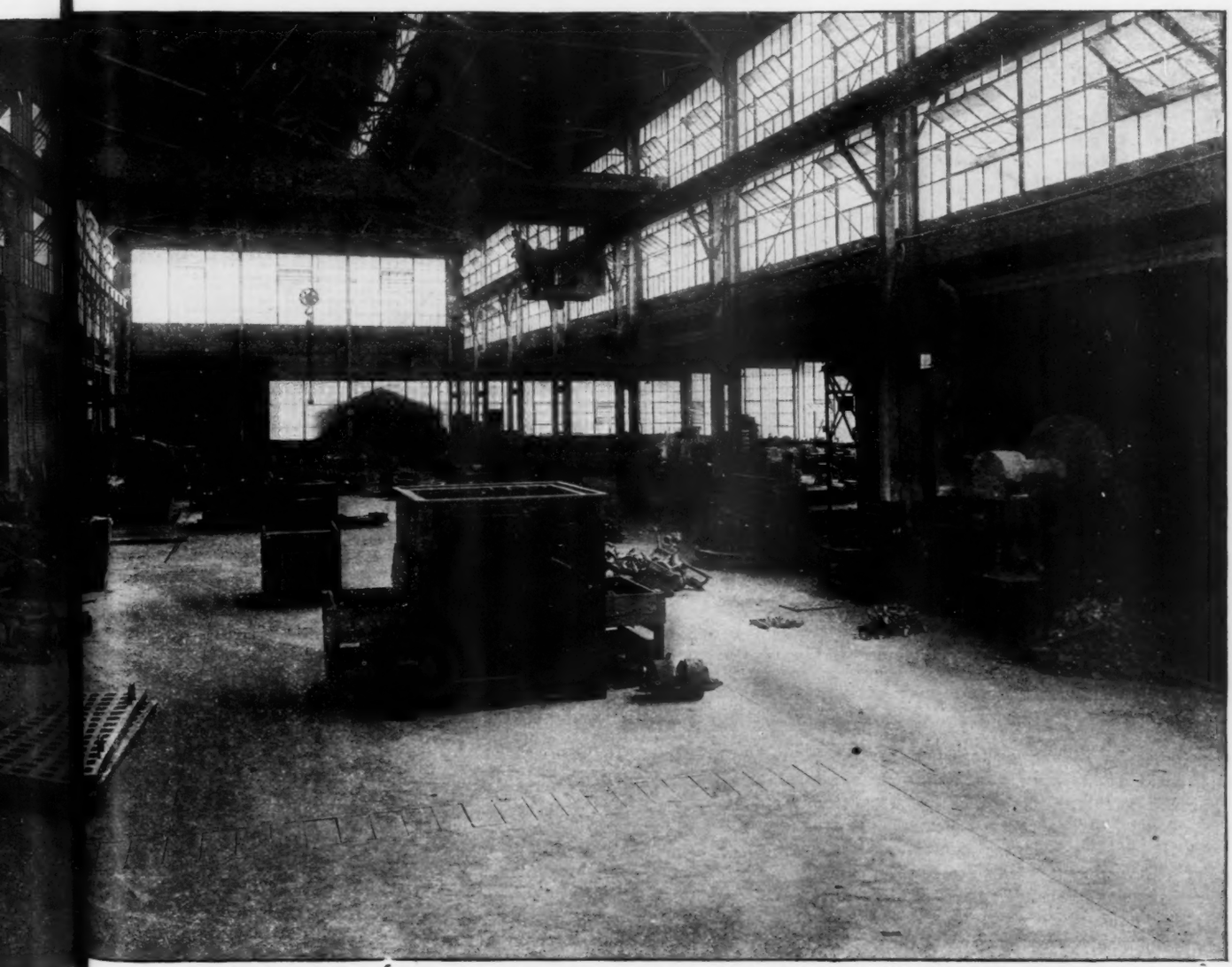
FIG. 3—NO WALLS IN THE FOUNDRY OBSTRUCT THE GENERAL VIEW—THE MOLDING FLOOR AND CORE ROOM ARE BACK OF THE ELECTRIC FURNACE SHOWN FROM WHENCE THEY GO TO THE GRINDERS AND THE ANNEALING OVEN

The final expansion will be the erection of a duplicate building connected with the other one by a covered stock and shipping department 63 feet wide. The last addition will be laid out somewhat similarly to the other half, as shown in Fig. 4. The main difference will be that the last section will contain two furnaces instead of one, and the annealing and other departments will be somewhat larger. This is accomplished by having the last addition 134 feet wide compared to a width of 116 feet in the first section, although both are 395½ feet long. The single furnace will have a molding space of 17,260 square feet, while the room with the two furnaces will have a molding floor of 25,540 square feet.

With the final arrangement the stock will be received between the two sections of the foundry where it will be stored under cover, protected from the rain and snow and the sand will be kept from freezing. The furnace charges will be made up in this center section at a point directly between the furnaces in the two divisions. The shipping platforms of both divisions will be towards the entrance of the center section, and railroad tracks will extend in front of them, back to the rear of the stock bay. The location of the offices and the locker rooms with the shower baths may be noted in the plans. A separate building is provided for pattern storage and for flask and pattern repairs.

*Basic Lining Installed*

One of the first things to be decided in choosing to the foundry equipment was the kind of electric furnace to be secured. A 3-ton Greaves-Etchells furnace made by the Electric Furnace Construction Co., Philadelphia, was selected. This furnace is basic lined with a magnesite bottom 24 inches thick. The main characteristics of the furnace include two 10-inch graphite electrodes through the roof and one electrode through the under case of the furnace imbedded in the bottom. Before the bottom is heated the third electrode acts as an insulator and no current flows through. At this stage of the melting operation current is single phase, but as soon as the bottom becomes heated the third electrodes becomes a conductor and the current changes to three phase. The electrodes are kept in adjustment by an automatic control mechanism manufactured by the General Electric Co., Schenectady, N. Y. The top electrodes are fitted with water cooling jackets where they enter the roof. These jackets cool the gases coming from the furnace around the electrodes and prevent the gases from igniting and burning the electrode. These jackets may be noted in Fig. 5, which illustrates the furnace pouring a heat of steel. Water meters are used to determine the amount of water passing through the electrode coolers and through the transformers which also must be kept cool. As a precaution against overheating an open drain has been installed for the cooling water. Should it stop flowing or be-



CENTER—CASTINGS ARE BROUGHT FROM THE MOLDS TO THE SANDBLAST AND THE SPRUE CUTTER AT THE RIGHT, THEN TO THE WELDER IN FRONT BOXES TO THE LEFT FOR HANDLING CASTINGS

come much overheated at any time the fact would be noticed at once as the drain is in a conspicuous place.

Current is used at 110 volts during the early part of the heat, but towards the end it is cut to 80 volts. It has been found that four heats can be taken off in a day of one turn, and it is estimated that for 24-hour operation, eight heats could be tapped in a day. A characteristic charge is made up of boiler plate, 0.30 per cent carbon, and enough spring clippings, containing around 0.90 per cent carbon, to bring the carbon in the melted steel to between 0.10 and 0.15 per cent. The sulphur and phosphorus in these grades of scrap are low, but both elements are further reduced in the electric furnace so that the finished steel is always well below 0.04 per cent in both sulphur and phosphorus. A second slag is rarely, if ever, used to reduce the amount of these elements in the steel.

While the majority of the castings are not sold under specifications as to composition, the company requires that the metal in the castings contain within a certain percentage of the amount of carbon, silicon, and manganese which characterizes the particular grade of casting into which the metal is cast. For this reason, preliminary tests are made of the metal in the furnace for carbon and manganese. Should the carbon be too low in the preliminary test it is raised by adding either pig iron or carbon briquettes, secured from the National Carbon Co., Cleveland. To do this the slag is slushed back to expose the bare metal and the additions do not touch the slag. Carbon is reduced by oreing, and later reducing the slag with a mixture of lime and coke dust. Coke dust is not used to raise the percentage of carbon in the metal because the results are not as dependable as when either of the other two materials is used. The company is strict in regard to the amount of carbon in the steel because a variation of the carbon changes the machining qualities of the steel and lack of uniformity of the product would cause trouble in the machine shops of the customers.

Metal is poured from the furnace into a 3-ton, tea-pot ladle and from this it is transferred to hand ladles for pouring the smaller molds. The metal

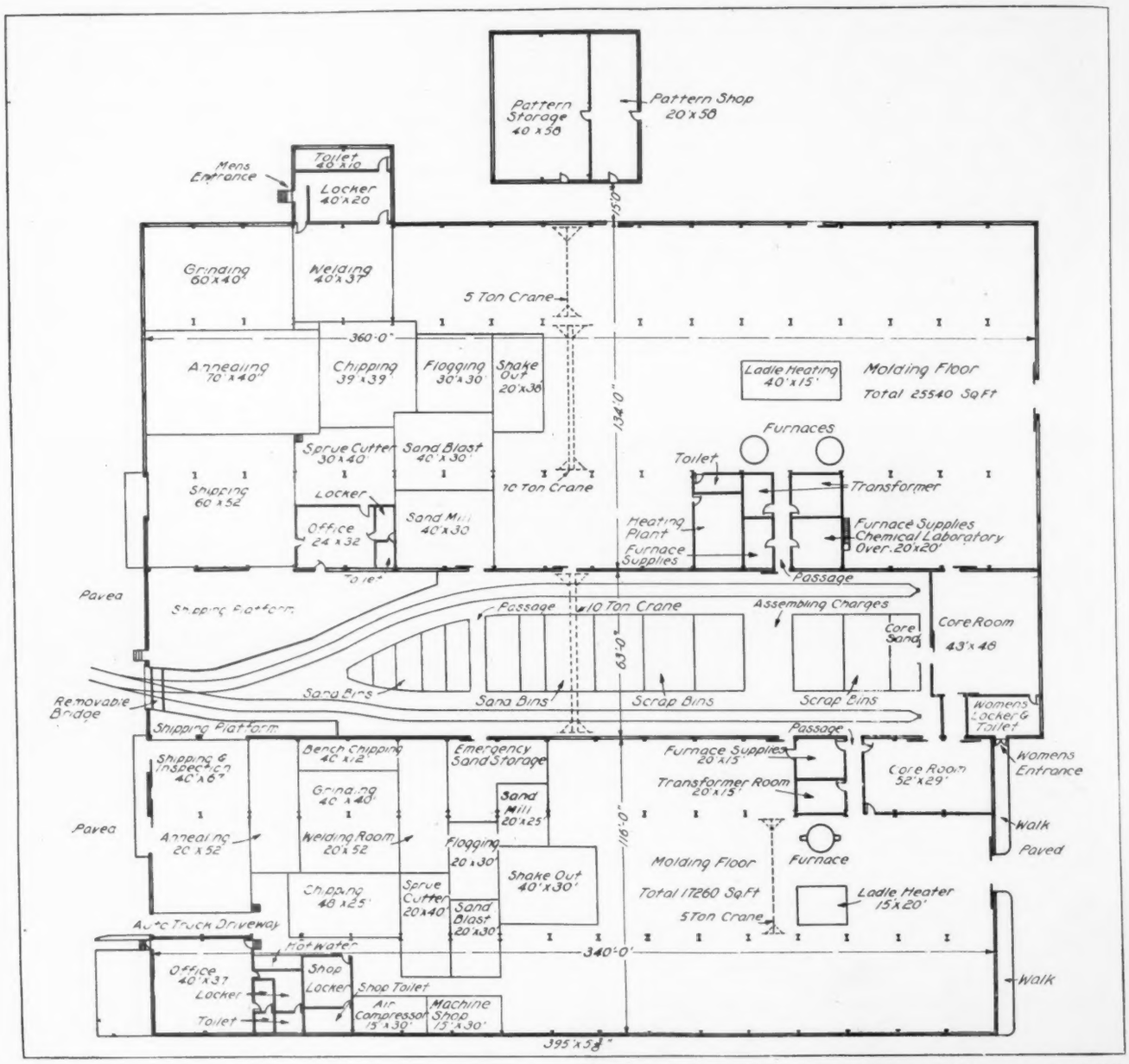



FIG. 4—THE FIRST ADDITION TO THE FOUNDRY WILL RESULT IN THE ARRANGEMENT ILLUSTRATED IN THE LOWER SECTION—WHEN THE FINAL ADDITION IS BUILT, A COVERED STOCK BAY BETWEEN WILL CONNECT THE TWO SECTIONS—THE PATTERN REPAIR AND STORAGE WILL BE HOUSED IN A SEPARATE BUILDING

FIG. 5—THE CONTROLLER FOR TILTING THE FURNACE IS LOCATED SO THAT THE OPERATOR CAN SEE THE SPOUT

is taken from the furnace at a high temperature and it is kept hot as long as possible by having the ladles well heated. All ladles are heated by a heater furnished by the General Combustion Co., Chicago. This heater, Fig. 6, is oil fired. The combustion chamber and flues are underneath and the heat comes up under the ladles. A 5-ton crane, built by the Shepard Electric Crane & Hoist Co., Montour Falls, N. Y., carries the metal to the molds. This crane spans the central bay of the foundry over the molding floor.

Only a small section of the molding floor, 30 x 30 feet, is covered with sand, the remainder being concrete like the floor in the remainder of the shop. A sand mill with a bucket loader, furnished by the National Engineering Co., Chicago, is located at one corner beside the molding floor. Sand is carried to the mixer from the sand storage directly behind it, in boxes. Sand also is delivered from the mixer to the molders in boxes. These boxes are designed so that one load will fill the sand mill. All facing sand is kept in boxes near the molders. The sand handling boxes are moved with lift trucks. Practically all the castings are poured in green-sand molds and good results are secured by this process. To start the foundry, old sand was secured from another shop. New sand is brought from the district around Millville, N. J.

A full complement of machines has not been installed as yet. At present one plain jar-ram machine with an 18 x 20-inch table, made by the Dayton Molding Machine Co., Dayton, O., is

FIG. 7—CASTINGS ARE TAKEN IN AT ONE WINDOW AND PASSED OUT AT THE OTHER IN THE WELDING ROOM

FIG. 6—LADLES ARE HEATED ON AN OIL-FIRED HEATER

installed. Foundations are in place for three additional jar-ram machines, with air connections under the concrete floor. The company also has one 8-inch and one 13-inch squeezer machine in operation.

Cores are made in a section back of the furnace, adjacent to the molding floor. They are baked in a 4-drawer oven, fired with oil. The oil used for heating is stored in a 15,000-gallon tank some distance from the building. This tank is above ground and in cold weather must be heated by a steam coil. Steam also is used to heat the foundry building in winter.

From the time the castings leave the molding floor until they are ready to ship, they are carried in boxes to the different stages of their finishing opera-

FIG. 8—THE CAR-TYPE ANNEALING OVEN IS HEATED WITH OIL—AN EXTENSIVE PYROMETER SYSTEM REGISTERS THE TEMPERATURE AND INDICATES TO THE OPERATOR BY MEANS OF LIGHTS WHEN THE TEMPERATURE IS TOO HIGH OR TOO LOW

tions. These boxes, some of which may be noted in Fig. 3, are held well above the ground by long side supports, so that the castings are easily reached by the workmen. Being carried in boxes the castings are taken in their order and always may be located, there being no danger of a desired casting being hidden under a large pile of other castings, as is sometimes the case when they are piled promiscuously on the floor. Small orders of castings are put in separate sheet-steel boxes inside the larger wooden boxes, to preserve their identity more effectively. After the castings come from the sandblast they are sorted and given a preliminary inspection. A route tag then is placed in each box, giving the pattern numbers and the number of castings from each pattern which are in the box. This route card is kept in the box until it reaches the shipping department. In their travel from the sandblast to the shipping department, the castings are given several inspections. First, as has been said, they are inspected as soon as they leave the sandblast. They also are inspected after they leave the sprue cutter and again in the chipping and grinding department. The final and closest inspection is received just before they are shipped from the plant.

All castings are annealed to improve their physical properties and to make them easier to machine. The annealing oven, shown in Fig. 8, was furnished by the General Combustion Co., Chicago. It is oil fired with the burners near the top. The car which forms the bottom of the oven has flues from one side to the other and the hot gases, passing through these flues to the stack, heat the bottom of the oven. A sand seal prevents the products of combustion from reaching the under part of the car and heating the wheels and journals. The car is pulled into and out of the oven by a block and tackle. When the castings are taken from the boxes to be placed on the annealing car, the route cards are set in a form in the relative position which the castings occupy on the car. This serves to identify the different lots of castings after the anneal. The general practice is to pile the castings on two grids, shown in the center, Fig. 3, and load the grids on the annealing car with the crane.

### *Complete Pyrometer System*

The necessity for having exact temperatures in the oven has been recognized and a complete control system consisting of a recording and indicating pyrometer has been installed. This system was manufactured by Leeds & Northrup Co., Philadelphia. As may be noted in Fig. 8, an indicating instrument with four lights is located on a panel at the furnace. The main instrument, which is a recorder designed on the potentiometer principle and which regulates the lights and indicator at the furnace, is located in the laboratory. An instrument based on the potentiometer principle is thought to have an advantage over instruments which require a flow of current, in that with the potentiometer no current flows, but the electromotive force generated by the couple is balanced by a standard cell

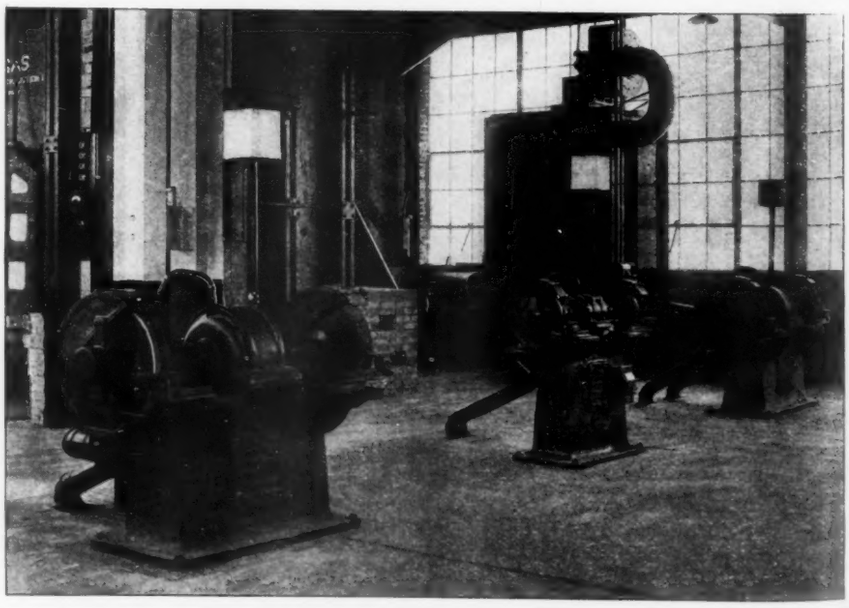


FIG. 9—WORN WHEELS ARE TAKEN FROM THE GRINDERS AT THE SIDE AND USED ON THE HIGHER SPEED GRINDER IN THE CENTER

governed by standard resistance. As no current flows, changes of resistance in the circuit due to change of temperature and poor connections do not alter the temperature reading of the instrument.

In operation, a record of the temperature of the charge is made from two couples at different parts of the oven, by the recording instrument in the laboratory. Through this instrument the indicating instrument is set to read the number of degrees the thermocouples are above or below any set temperature. The furnaceman does not need to know the exact temperature of the furnace. He only knows that the furnace is so much below or above the temperature desired by the metallurgist who sets the instrument. Three lights are white, red and green, respectively. The white light is on when the temperature of the thermocouple is within 15 degrees above or below the required temperature. When the temperature varies more than 15 degrees above the desired temperature the red light shines and when more than 15 degrees below the green light is lighted. The two thermocouples, of course, can not operate on the instruments at the same time. Therefore, the recording pyrometer is equipped with a mechanism for cutting in one thermocouple at a time. Each couple registers for one minute. The fourth light on the panel, which is blue, operates with one of the couples and is dark when the other is connected.

The equipment for cleaning and finishing the castings includes a sandblast mill, grinders, sprue cutters and welding apparatus. The sandblast is a 6-foot revolving table, with a dust arrester and cloth screen, supplied by the W. W. Sly Mfg. Co., Cleveland. Sprues are cut by a mechanical cutter and with a gas flame. Welding is done with an electric arc, the equipment being built by the General Electric Co., Schenectady, N. Y. A view of the welding room is shown in Fig. 7. Castings are brought to one side of the room in a standard box. The operator reaches through the window to get the casting. After it is welded it is allowed to slide down the sloping operating table to the other side of the room, and tossed out of the window into another box. The identification tag in the first box is transferred with the castings to the second box.

Three double-end floor-stand grinders, Fig. 9, have been secured from the Bridgeport Safety Emery Wheel Co., Bridgeport, Conn. As may be noted, these all are direct connected and the motors are cooled by an air blast. Direct connection is a feature of this shop and there are only three belts in the entire plant. The pipes extending from the rear of the grinders are exhaust ducts which lead into a main pipe under the cement floor. This pipe is continued and connections are reserved for more grinders which it will be necessary to install with increased operations. The two end grinders operate at 900 revolutions per minute, while the middle one runs at 1200 revolutions per minute. With this combination wheels which become too small for the slower machines are put on the higher speed grinder and more service thus is obtained from them. As may be noted in Fig. 9, all wheels have safety collars. In addition to the floor-stand grinders, the company has installed one swing grinder manufactured by the Mummert-Dixon Co., Hanover, Pa. A blower has been installed to furnish air for the annealing oven, core oven and ladle heater, and a compressor supplies air at 80 pounds pressure to the molding equipment. A reducing valve is used on the compressed air line for the sand blast where a pressure of only 35 pounds is used.

The importance of an exact cost system was recognized by the company and a plan involving job cards to secure the costs of individual lots of castings was adopted. Until the actual costs could be obtained a selling curve for different classes of castings based on weight was compiled from estimated costs. Prices on this curve are modified according to whether the castings are cored, whether the cores are specially difficult, whether the castings have unusally thin sections, and according to the way the pattern is mounted.

## Effect Consolidation of Equipment Firms

A recent consolidation has been effected whereby two of the leading foundry equipment companies in the field are combined. The new organization, which will be known as the Whiting Corp. with headquarters at Harvey, Ill., embraces the Whiting Foundry Equipment Co. of that city and the American Foundry Equipment Co., New York.

J. H. Whiting, president of the Whiting Foundry Equipment Co., becomes chairman of the board of the new organization and V. E. Minich, president of the American Foundry Equipment Co. is president of the new corporation which is capitalized at $5,000,000. Mr. Minich is president of the Foundry Equipment Manufacturers association.

As the lines of manufacture of the component companies do not overlap it is the intention to maintain all present manufacturing facilities. The Whiting plant at Harvey, will continue the manufacture of cranes, cupolas, hoists, tumbling mills, core ovens and all other items of its established line, together with sand blast equipment and dust arresters. Sand cutting machines, charging trucks, core machines and steel flasks will comprise the bulk of work at the new plant built by the American Foundry Equipment Co. at 2935 W. 47th St., Chicago. This work will be directed by E. A. Rich Jr. Molding machines, jolts, flask specialties and pattern mounting materials will continue to be manufactured at the York, Pa., plant of the American company in charge of R. S. Buch.

The plans include maintaining and enlarging the present offices of the American Foundry Equipment Co., 366 Madison Ave., New York, as the eastern sales and export office of the combined organization.

## Foundry Exhibitors at London Tool Show

Although confined mainly to machine-shop equipment, there were two exhibits of foundry apparatus at the Machine Tool and Engineering exhibition which was held at Olympia, London, Sept. 4-26 under the auspices of the British Machine Tool Trades association.

Macnab & Co., Southampton Row, London, WC1, showed a working exhibit of Tabor molding machines, which are now being built in England under license from the Tabor Mfg. Co., Philadelphia. This exhibit which was in charge of W. T. Coleman, included a shockless turn-over jar-ramming machine of 3000 pounds capacity together with a number of plain jar ramming machines and a Tabor power squeezing split-pattern machine. British made foundry equipment was exhibited by the Britania Foundry Co., Coventry. This firm showed a full line of plain jar ramming machines together with sand mixers, pattern-plate making apparatus, core ovens, etc.

## Purchases New Plant

The Kennedy Corp., Baltimore, Md., recently has purchased the entire capital stock and has assumed control of the Baltimore Malleable Iron & Steel Casting Co. The Kennedy Corp. which was formed early this year, specializes in the manufacture of automobile and tractor castings, and recently has entered on the production of freight car and locomotive parts. Contracts have been let for extensions and alterations to the Baltimore Malleable plant under direction of Frank D. Chase, Inc., Chicago.

# Institution of British Foundrymen

## Glasgow Meeting Reflects Growth of Association—Brass Foundry Casting Temperatures, Scientists in the Foundry and Cast Iron Research Were Among the Topics Discussed

TO THE world-famed hospitality of Scotland is due no small share of the success of the seventeenth annual convention of the Institution of British Foundrymen, which was held in Glasgow, Aug. 25-27. The extensive facilities of the Royal Technical institute in George street were placed at the disposal of the visitors for their technical sessions, the plant visitation arrangements were unusually complete, and it is not too much to say that the entertainment features arranged by the Scottish branch could not have been improved upon. The meeting was one of the most largely attended in recent years.

*ONE of the outstanding features of the seventeenth annual meeting of the Institution of British Foundrymen held in Glasgow last month was the unanimous resolution extending greetings from across the sea to the American Foundrymen's association, coupled with best wishes for the success of the great foundrymen's convention and exhibition which will be held at Columbus, O., Oct. 4-8. It is understood several members of the Institution of British Foundrymen are going to Columbus for the purpose of conveying the greetings of the British foundrymen in person. Throughout the United Kingdom there is great interest in American foundry practice and cordial feelings toward the castings fraternity in the United States. It is realized that the industries in the two countries have many common problems, and it is hoped this may lead to a great joint Anglo-American foundrymen's convention in the future.*

A brief report of the proceedings has already been presented in the special cablegram published in the Sept. 15 issue of THE FOUNDRY. Some further particulars may now be added.

The convention opened with a general business meeting held Wednesday morning, Aug. 25. Early on the order of business was the resolution of greetings to the American Foundrymen's association already referred to. This motion was introduced by Oliver Stubbs, J. Stubbs, Ltd., Openshaw, Manchester, senior vice president of the Institution of British Foundrymen. On behalf of the American Foundrymen's association the resolution was acknowledge by H. Cole Estep.

In the report of the general council, which was approved at the Wednesday business session, it is stated that although the formation of a branch of the institution at Liverpool is at present in abeyance, steps are being taken to open a branch in the Leeds and Bradford district, in the north of England, with headquarters at Bradford. The total membership of the Institution of British Foundrymen is now 1603, compared with 1544 in 1918-19. It is believed this figure makes the British association the largest technical society of foundrymen in the world. The arrangements for obtaining a royal charter are now nearly completed. The financial statement presented with the council's report indicates that the institution is in sound condition, but the great increases in expenses during the past year show that an advance in the annual dues is necessary.

Accordingly a resolution was passed increasing the fees as follows: Members to £2 2s ($7.50 at exchange current on Sept. 1); associate members to £1 1s ($3.80); associates to 10s 6d ($1.90); firm memberships to £5 5s ($19.00). This resolution was introduced by M. Riddell, president, and seconded by John Little, past president. The convention approved the revision of the rules and by-laws of the institution which have recently been overhauled by a committee appointed by the council. Officers were elected for the ensuing year as reported in the Sept. 15 issue, and M. Riddell, Watson Gow & Co., Falkirk, Scotland, the new president, was conducted to the chair by John Little, the retiring president. In his final remarks before leaving the chair, Mr. Little referred to the arrangements being perfected for an exchange of papers between the British and American Foundrymen's association. H. L. Reason, John Russell & Co., Ltd., Birmingham, the newly elected junior vice president, was appointed to represent the institution on the recently formed British Gray and Malleable Cast Iron Research association. Illuminated addresses were presented to T. H. Firth, Brightside Foundry and Engineering Works, Sheffield, and to John Little, Manchester, past presidents, in recognition of their services to the institution.

In his presidential address, Mr. Riddell referred to the tremendous growth of the association, pointing out that at the first meeting in Manchester in 1904 there were only 100 members. He referred also to what has perhaps become his life's hobby, promoting the education of young men for the foundry business. There are few professions, he said, in which more mental and artistic ability is required than in the foundry industry. The importance of education in the foundry business, he said, is further emphasized by the fact that "cast iron is the bread of life for all other industries." Mr. Riddell believes that employers should take more interest in the education of apprentices and others for foundry work, but he does not favor the tendency exhibited in some directions to make the work too easy.

A paper entitled, "Measurement of Casting Temperatures in the Brass Foundry," was presented at the Wednesday morning session by John Arnott, G. & J. Weir, Ltd., Glasgow. In this paper the author states that nonferrous

metals are more affected by differences in casting temperatures than iron. The paper then goes on to describe some of the difficulties of measuring the temperature of molten metal in non-ferrous foundries and concludes with a detailed description of different types of pyrometers. Interesting practical hints on the operation of pyrometers also are included. This paper is presented in full on pages 766 and 767 of this issue.

In the discussion, F. J. Cook, Rudge & Littley, Ltd., West Bromwich near Birmingham, said that in his opinion too much importance is attached to reading to exact temperatures in iron foundries, the purpose of pyrometer readings being to obtain comparative results for the guidance of practice rather than absolute temperatures. In this connection he referred to the usefulness of the optical pyrometer for taking pouring temperatures. H. L. Reason, John Russell & Co., Ltd., Birmingham, said that in his opinion considerable further investigation of casting temperatures in brass foundries is necessary in order to reduce losses, particularly in shops making valves, fittings and other castings that must withstand hydraulic pressure. John S. Primrose, Ransomes & Rapier, Ltd., Ipswich, submitted a written discussion.

In concluding the discussion, the author stated his objections to the optical pyrometer on account of slag difficulties. He said further, that although the optical pyrometer is useful for taking pouring temperatures, such temperatures are not as valuable as melting temperatures since there is no opportunity to rectify errors in melting after the molds are poured. He also said that in his opinion pyrometer readings should give the exact temperature as accurately as possible in order to make possible comparisons between different plants and even different countries.

TALKING IT OVER ON LOCH LOMOND

F. J. Cook, Rudge & Littley, Ltd., West Bromwich, on the right; and Prof. A. Campion of the Foundry Technical institute, Falkirk, on the left.

### *Scientific Foundry Management*

Two papers were presented at the technical session held Thursday morning, Aug. 26. W. H. Cathcart, Lobnitz & Co., Ltd., Renfrew, Scotland, read a paper entitled "Science in the Workshop." The other paper, "Future Research on Cast Iron," was read by J. H. Andrews, professor of metallurgy, Royal Technical College, Glasgow.

Mr. Cathcart was awarded the Blacksmith gold medal by the Iron and Steel institute this year. His paper deals with the problem of harmonizing the work of practical and scientifically trained men in foundries. The paper indicates that in the author's opinion it frequently is easier to give a certain amount of scientific training to a practical man than to initiate a scientific man into the mysteries of shop practice. This view was not wholly agreed to in the discussions.

Professor Andrews in his paper on "Future Research on Cast Iron" called attention to the lack of frankness exhibited by shop-trained men, who, he said, sometimes exhibit more willingness to absorb information than to impart it.

S. G. Smith referred to a problem connected with making turbine nozzles and diaphragms in which applied science was of special assistance, and it resulted in the discovery that gray iron is a more suitable material than steel for this purpose. He also said that he believes more blow holes are caused in castings from bad molding and improper sand than from incorrect melting. This latter statement was disputed by another speaker.

R. Buchanan, Birmingham, past president, called attention to the difficulty in getting proper results from laboratory control due to the lack of practical knowledge in many cases on the part of laboratory directors.

In his paper "Future Research on Cast Iron", Professor Andrews said that the fact that dilatation curves showing the expansion and contraction on heating and cooling have proved themselves of great value in steel research is alone sufficient recommendation for their trial on cast iron problems. Professor Andrews also said that any marked changes in constitution occurring during heating or cooling are very clearly shown up by a temperature-resistivity curve. For instance the deposition of graphite or temper carbon would produce a marked increase in the electrical resistance. Would not this then, he continued, be an excellent method to use in the case of malleablizing practice? It would give us at once the temperature at which carbon began to be deposited, and also the temperature of the maximum rate of deposition.

Professor Andrew's paper was discussed by J. Shaw, Brightside Foundry and Engineering Co., Ltd., Sheffield, and Benj. Hird, Allen & Simmonds, Ltd., Reading England.

THREE FROM BIRMINGHAM

D. H. Wood, Constructional Engineering Co., on the left; H. Roe, Adaptable Moulding Machine Co., on the right; Thomas Vickers, secretary, British Grey and Malleable Cast Iron Research association, in the rear.

The entertainment features included a municipal reception and tea given by the City of Glasgow in the city chambers on Wednesday afternoon, Aug. 25, at which an address was made by the lord provost of Glasgow, with replies by Messrs. Riddell and Buchanan on behalf of the Institution of British Foundrymen.

On Thursday afternoon a special train conveyed the party to the British works of the Singer Mfg. Co., near Glasgow, where not only the extensive foundry operations of this concern but all the details of sewing machine manufacture were inspected. Friday, Aug. 27, was given over to an all day excusion to Loch Lomond including an 80-mile steamer trip through some of Scotland's most beautiful and historic regions.

# Heat Control in Nonferrous Melting

## Temperature at Pouring Exerts a Marked Influence in the Quality of Nonferrous Castings — British Methods of Measuring Are Outlined and Instruments Described

BY JOHN ARNOT

OF THE various factors which influence the quality of castings, temperature is undoubtedly one of the most important. It would appear at first sight that nonferrous metals are more affected by differences in casting temperatures than cast iron. It is probable that the difference between cast iron and brass in this respect is more apparent than real. The various types of furnaces in use for melting nonferrous metals should, if they are to be reasonably rapid and economical, be capable of heating the metal considerably above the desired temperature, whereas in the cupola the iron receives little heat after it has been melted. Therefore the possible temperature range of cast iron melted in a cupola is smaller than that of nonferrous metals melted in coke and gas furnaces. Many of the modern furnaces, such as coke and oil tilting units, are capable of bringing the metal to pouring temperature in less than an hour, and if it remain another 20 minutes or more subjected to full blast the metal will be much too hot.

Measuring temperatures of molten metals is a difficult problem. It does not seem to have received the same attention as the measurement of temperatures of annealing furnaces. In such work as annealing, pyrometry has reached a high standard. Even small shops have pyrometers installed in their furnaces, while the installations in some of the motor car works are on a most elaborate scale. In the foundry the position is different. Comparatively few foundries have made any attempt whatever to measure temperatures, while the number where such readings are regularly taken is small indeed.

### *Thermocouples Fragile*

Thermocouples most commonly are used. These couples have platinum as one element and an alloy of platinum and iridium or platinum and rhodium as the other. Owing to the high cost of platinum the wires are small in diameter and also short. The general arrangement of such a pyrometer is a steel tube 2 feet 3 inches long and 1 inch in diameter which serves as a handle. At one end this tube is screwed into the junction box in which the platinum wires are connected to the copper leads. At the other end, the steel tube is fitted to a coupling piece. A graphite sheath 13 inches long, 1 inch bore and ½-inch thick in walls, closed at one end, is screwed on to this coupling piece. Since graphite is permeable to gases it is necessary to encase the platinum wires in a silica tube closed at the lower end. The platinum wires are insulated throughout their length by short pieces of silica or porcelain tube. The whole arrangement is expensive, cumbersome, and easily broken. The most serious objection, however, is the time lag. The thick graphite sheath and the inner silica tube both serve as all too efficient heat insulators, and readings are nearly always low. On this account much of the early data published on the effect of casting temperatures is unreliable. For example, tests on admiralty gunmetal at temperatures below 1000 degrees Cent. are quoted. Reference to the thermal diagram of the copper-tin alloys shows that the larger part of the alloy is solid below 1000 degrees Cent. In my experience castings poured at even 1030 degrees Cent. are nearly always unsound.

A modification of this instrument is a nichrome sheath in place of graphite. The instrument is thereby rendered more serviceable, but, while the time lag is certainly less, it is still too great for ordinary use, and in addition the apparatus is heavy. Protection tubes of carborundum and similar materials are now available. These are fairly strong, and have a low coefficient of expansion and a high heat conductivity. It is not permissible to have the platinum wires in direct contact with the carborundum tube, hence an inner tube of porcelain or pure silica is necessary.

Base-metal couples now are made by several firms. In some of these an outer steel tube acts as one element while the other element is a nickel or a nickel-copper alloy wire insulated by short pieces of poreclain tube. This construction is cheap, strong, and allows of easy repairs, because when the hot junction is burned out it is only necessary to cut the tube and make a new weld. In some of the base-metal couples the two elements are copper or nickel alloys, and hence require to be insulated both from each other and from the steel tube. One advantage of the base metal couple is that for a given temperature the electromotive force is much greater than that given by a platinum couple. This allows a less delicate galvanometer to be employed, which is no small matter under foundry conditions. Base-metal couples are satisfactory for taking temperatures of molten aluminum. For this purpose I have found that in order to get the best life from a couple the aluminum should never be allowed to come into contact with a clean surface of the steel tube. If the end of the couple which is immersed is previously painted with graphite or clay wash it will be found to last much longer. In fact, I have found the best life to be obtained from thermocouples which had previously been used for some time in annealing furnaces and had thereby become covered with oxide.

Resistance pyrometers depend on the alteration of the resistance of a spiral of platinum wire at high temperatures. Great accuracy is possible by this method, and in addition by checking the resistance of the wire when cold it is easy to detect any deterioration in the platinum. For application to molten metals, sheaths are necessary as for the thermocouple, and a simliar time lag is unavoidable.

### *Radiation Avoids Contact*

The radiation pyrometer has the advantage over the thermocouple that there is no contact between the molten metal and the instrument. The principle of the radiation pyrometer is, briefly, that the heat radiated from a hot body is, by means of a concave mirror, brought to focus upon a point which is the hot junction of a platinum thermocouple. The thermocouple is connected to a galvanometer in the ordinary way. The difficulty experienced with radiation instruments is that it is extremely difficult to obtain a surface of metal free from

A paper presented at the annual meeting of the Institution of British Foundrymen, Glasgow, Aug. 25-27. The author, John Arnott, is metallurgist, G. & T. Weir, Ltd., Glasgow.

slag and oxide films. Unless this is done the readings are unreliable.

The optical pyrometer has found considerable use in operations of annealing, reheating, etc. While many of the cheaper instruments, in which the light radiated from a hot body is compared against a standard color, are not to be relied upon to any great accuracy, instruments such as that made by the Cambridge Scientific Instrument Co., in which the light radiated from the hot body is compared with that from a standard lamp, can be considered reliable to a matter of well under 1 per cent. To obtain reliable readings from an optical pyrometer it is necessary that "black body" conditions be present. Since these do not apply to metal in a crucible some correction is necessary.

Optical pyrometers are affected, probably to a greater degree than radiation instruments, by the slag and fumes which are generally on the surface of molten brasses.

To sum up the various instruments as far as foundry work is concerned, the thermocouple and the resistance pyrometer must be used with a sheath and are hence too slow, while radiation and optical instrumnets give unsatisfactory readings on account of the slag and fumes. To be really of service in the foundry a pyrometer should have the following characteristics: It should be accurate within 1 per cent. This means a maximum error of 10 degrees at 1000 degrees Cent. It should be capable of use up to 1300 degrees Cent. if required. It should be direct reading and involve no calculation whatever. It should indicate the temperature of molten metal within, at most, one minute of immersion. It should be strong and not easily put out of order; or at any rate, it should permit of easy and cheap repair. It should not be too expensive.

I am strongly of the opinion that an immersion method is the only one of any use for molten metal, and further that the couple must be used either bare or with only a wash of refractory material on it.

Platinum is much too expensive. Iron and alloys of iron are too readily dissolved by the molten metals. The only commercial alloys left are those of nickel. For some time back a couple has been made in America of which one element is almost pure nickel and the other an alloy of nickel with about 9 per cent of chromium. This gives an electromotive force of over 40 millivolts at 1000 degrees Cent. so that a robust galvanometer can be used with it. The two wires are encased for most of their length in a steel tube, leaving only a few inches of bare wire for immersion. Inside the tube they are insulated from each other by asbestos woven to a tubular form, or by pieces of porcelain tube.

I have used such a couple regularly for over a year and have found it very satisfactory. In the brass foundry at the Cathcart works of G. & J. Weir Ltd., the temperatures are taken of all melts of manganese brass and of all melts of gunmetal from which important castings are made. The wires are welded together and when the junction is burned through they can be rewelded in a couple of minutes in the oxyaceteylene flame.

In molten brass or manganese-brass at 950 to 1000 degrees Cent., the couples last a very long time. In molten gunmetal the life of the junction depends on the temperature of the metal. At temperatures of 1300 degrees Cent. and over the junction will only last one or two immersions, but at 1150 to 1200 degrees Cent. perhaps eight would be an average. The amount by which the couple is shortened each time the junction is burned through is only 2 inches at most, so that the actual cost of each immersion is very small.

I do not intend to dwell at length on the effect of casting temperatures since this paper is only concerned with the measurement of these. I might just mention the results obtained on gunmetal of composition roughly, 88 per cent copper, 9 per cent tin, 2.5 per cent zinc, 0.5 per cent lead. When cast at 1300 degrees Cent. the strength is approximately 9.5 tons per square inch at 1200 degrees Cent., 13 tons per square inch reaching a maximum of over 16 tons at 1150 degrees Cent. At temperatures of 1050 degrees and under the bars are unsound. One might imagine that the range of temperatures within which gunmetal is cast in foundries would be comparatively small. I am convinced that in the average foundry the casting temperature varies from about 1100 degrees Cent. up to 1300 degrees Cent. At Cathcart we have found that the casting range of manganese brass is small, and that for the soundest castings the temperature should be 970 degrees Cent. ± 20 degrees Cent.

In conclusion, I would like to say a word about the upkeep of pyrometers. In works where a large number is kept their repair and calibration becomes an important matter. While some pyrometers work satisfactorily for long periods without attention others most decidedly do not. If no indication whatever is given on the instrument the trouble may be due to hot junction burned through. This is evident at sight. It may be due to insulation of the thermocouple becoming defective. This is easily tested by trying on a millivolt-meter. Or it may be bad contact between thermocouple and instrument.

If the readings are incorrect the error may be due to alteration in the resistance of a couple, possibly caused by its length being reduced; instrument out of balance; or alteration of tension in hair spring of instrument.

## Oxides in Iron

An interesting discussion of the paper on "Future Research in Cast Iron," read at the Glasgow convention of the Institution of British Foundrymen, Aug. 25-27, has been contributed by J. Shaw, Brightside Foundry & Engineering Co., Sheffield, England. It is as follows:

"I was much interested in the methods of research for cast-iron suggested by Prof. Andrews, but the illustration he gave on the effects of additional lime in the cupola focused my attention. While I think the lime would most likely satsify itself from the silica of the lining of the cupola, and not the silicon of the iron, the chief point, in my opinion, is the existence of iron oxide in the metal and its results on the casting produced. This casting to be machinable must have contained at least 1 per cent silicon. Now Dr. Hatfield has given as his considered opinion that iron oxide cannot exist in cast iron which contains more than 0.3 per cent silicon. What I would like to know, did Professor Andrews actually test this metal for iron oxide or was it a mere theoretical deduction, if so what was its silicon contents? I ask this question in no quibbling spirit, but because in these days of poor fuel, fine ore and irregular blast-furnace working, I believe the inclusion of oxides in the metal as received from the blast furnace is one of vital importance to the foundryman. In my opinion it is also one of the chief causes of the discrepancy often observed in the physical tests of metals of the same ordinary chemical analysis.

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The Weatherly Foundry & Machine Co., Hazleton, Pa., has been sold to local and New York City interests, who have reorganized under the name of the Weatherly Foundry & Mfg. Co. Officers have been elected as follows: President, George W. Wilmot, Hazleton; vice president, T. E. Learned, New York; and treasurer, Joseph C. Hoffman, Hazleton.

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H. I. Landis, Lansdale, Pa., has sold his interest in the Lansdale Foundry Co. to J. F. High, who has assumed the active management of the company.

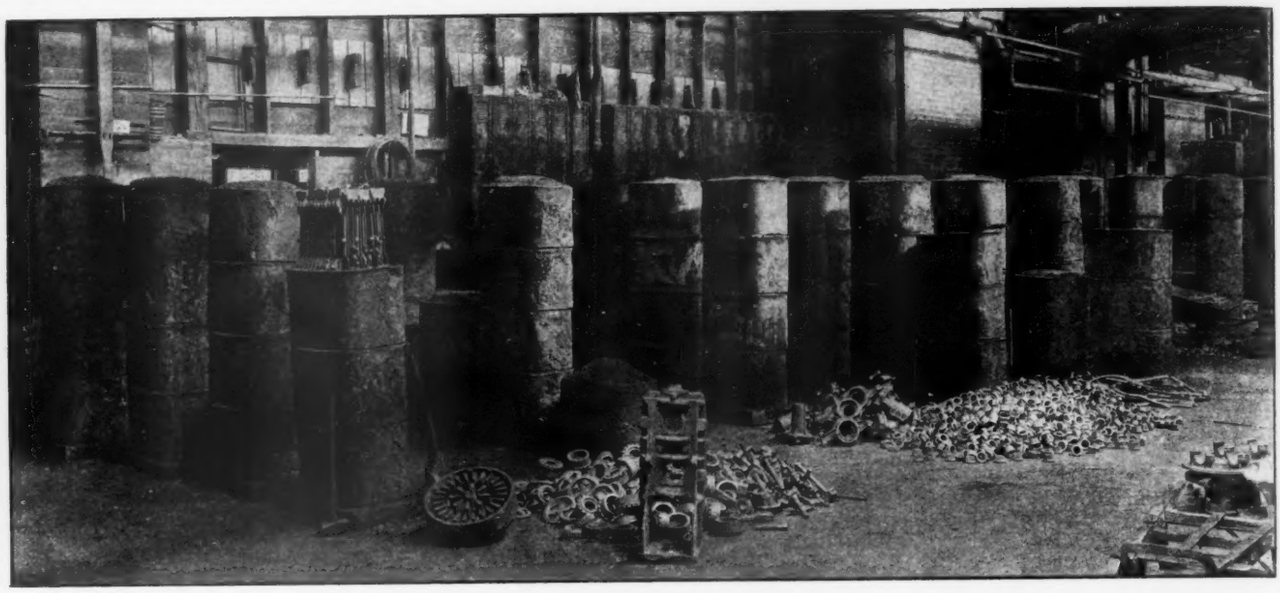

FIG. 1—ONE CORNER OF THE PACKING ROOM, SHOWING THE TIERS OF ANNEALING POTS READY FOR THE OVEN—THIS INDICATES THE CHARACTER OF THE WORK AND THE WAY IN WHICH IT IS HANDLED

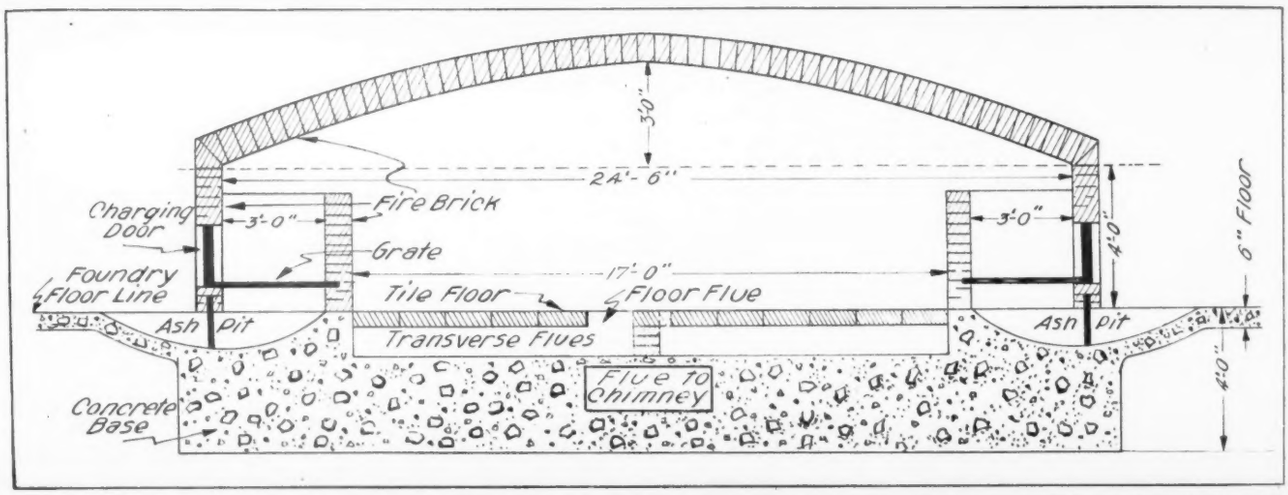


FIG. 2—FIREBOXES ARE SET WITHIN THE OVEN PROPER, TWO AT EACH END WITH FLUES IN CENTER BENEATH THE FLOOR AND CONNECTING WITH THE MAIN FLUE TO THE CHIMNEY

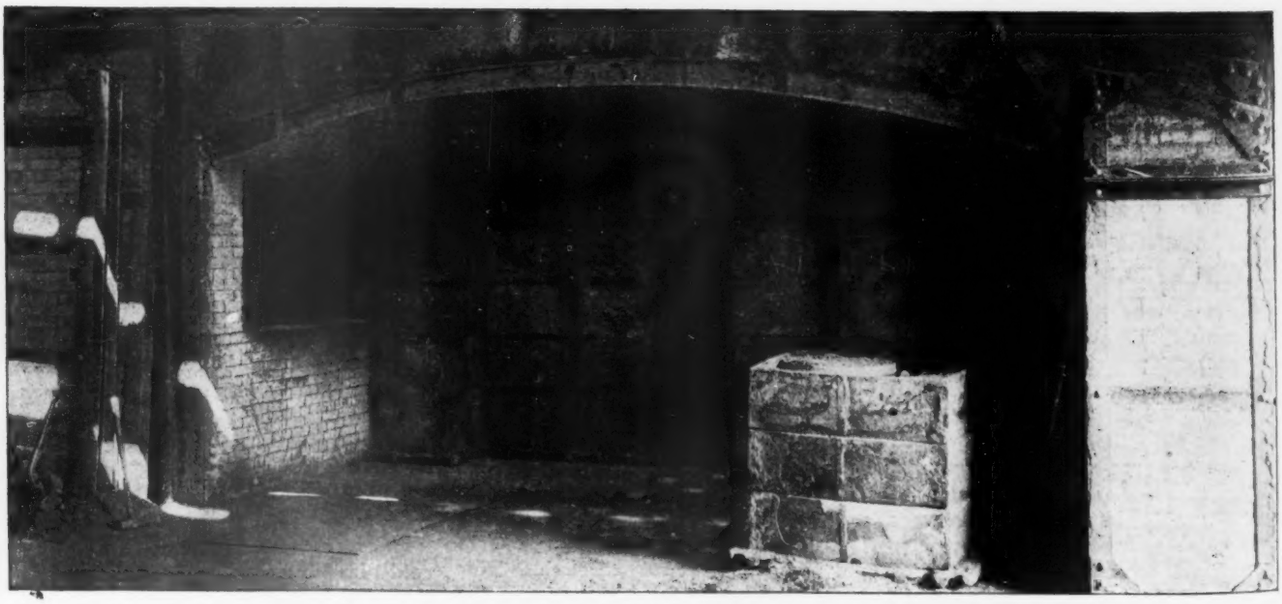

FIG. 3—HEAT COMES FROM BOTH SIDES AND PASSING OVER THE POTS GOES THROUGH FLUES IN THE FLOOR—THE METHOD OF SPACING THE POTS PERMITS FREE CIRCULATION OF THE COMBUSTION GASES THROUGH THE CHAMBER

# New Oven Secures Uniform Anneal

## Two Fireboxes at Each Side Are in the Oven Proper—Flues Are Located in the Center of the Floor—Four Tons of Castings Are Annealed with One Ton of Coal

UNIFORM heat in an annealing oven is important in the production of malleable iron castings and, realizing this, annealers have for many years varied the design of ovens according to individual ideas, attempting to obtain the most uniform working conditions. The designer of an annealing oven should consider, first of all, uniformity of temperature at all points throughout the annealing period and only secondarily the efficiency of operation. However, with the increasing scarcity of coal some additional expense in the original cost of the furnace is warranted if the efficiency is thereby increased. A new annealing oven designed to secure uniformity of heating and to conserve fuel has recently been built at the plant of the Arcade Malleable Iron Co., Worcester, Mass. The furnace was designed by John Jordan, foundry superintendent. Mr. Jordan has spent many years in the malleable iron industry and thus has become familiar with annealing castings. He started work in 1872 as a molder in the foundry of the Rhode Island Malleable Iron Works, Hill's Grove, R. I., and continued at this foundry until he was called to accept his present position in Worcester in 1912. At that time he was superintendent of the Hill's Grove plant. On his arrival at the Worcester plant, one of the first things he did was to change the annealing ovens by enlarging the openings between the fireboxes and the annealing chamber. Mr. Jordan has always found that having as large an opening as possible between the fire and the chamber of the oven tends toward greater uniformity, and now with his new oven he has practically reached the limit in this direction by placing the fireboxes in the oven itself. The results of the operation of this oven have in many respects been remarkable and the detail of its construction asumes general interest. The outstanding points in its operation are, first, almost absolute uniformity of temperature during annealing period and, second, low coal consumption per ton of castings produced.

FIG. 4—AN AIR HOIST SUPPORTS THE POTS WHILE TWO MEN JAR THE CONTENTS LOOSE SO THEY FALL TO THE FLOOR

The pots are placed in the oven with a charging truck. The pots containing castings are built up in tiers of four on cast base plates. In all the furnace takes 54 of these tiers in addition to several rows of extra single pots which may be placed in the space under the center of the arch. The base plates have series of feet which hold them off the floor in order that extension arms of a large charging truck may slide under and thus raise each tier to afford a reardy means of transportation without handling. The older type of furnace heretofore used at the plant was of smaller capacity and corresponding smaller firebox space. The new furnace is 24 feet 6 inches wide and 15 feet 9 inches deep inside measurements. However the working area is not as great as this because the space occupied by the four fireboxes must be subtracted. Each firebox has an inside area 3 x 3 feet leaving the charging floor proper approximately 16 feet square. In the operation of the furnace the charges have averaged about 35 tons of castings. For the purpose of determining the relative merit of the furnace design rather careful check has been kept of temperatures, fuel required and results. The fireboxes and grates are designed for the use of anthracite coal. Underneath the grates space has been left for ashes, so arranged that these may be easily removed from the outside of the furnace during operation. The furnace is equipped with recording pyrometers,

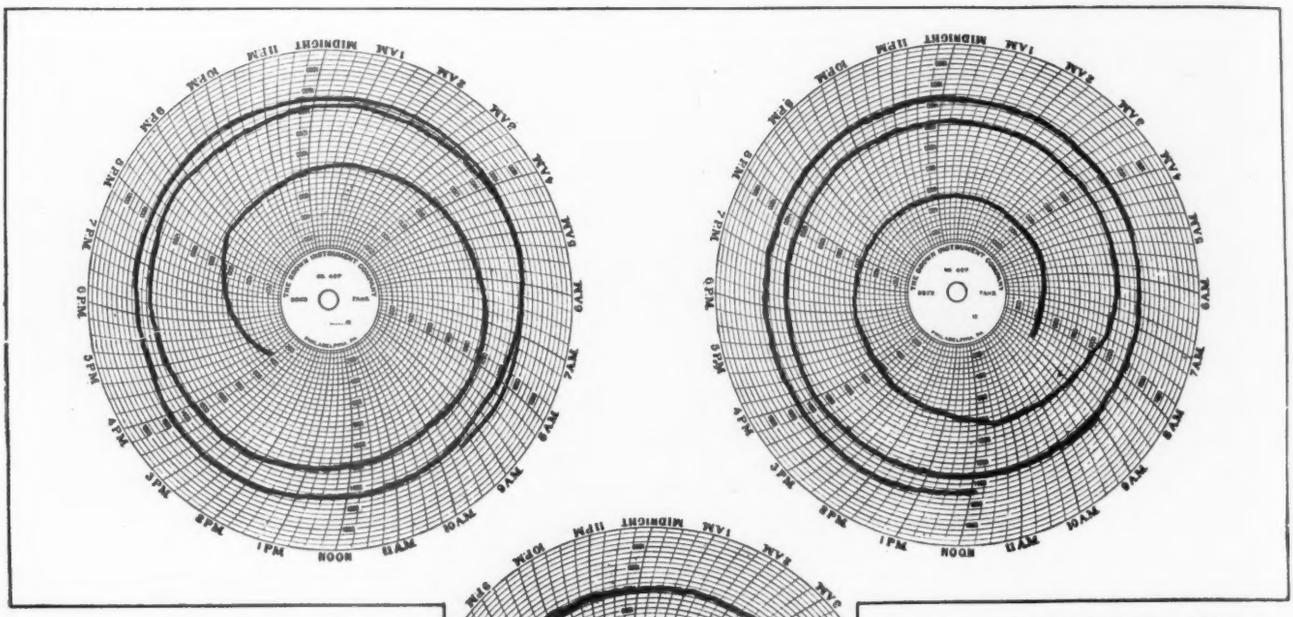

FIG. 5—THE RECORDING PYROMETER CHARTS INDICATE THE RISE IN TEMPERATURE IN THE OVEN

FIG. 6—PYROMETERS ARE LOCATED IN THE SUPERINTENDENT'S OFFICE

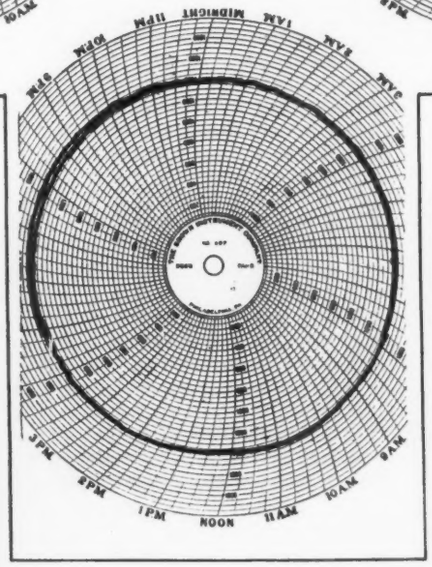

FIG. 7—THE TEMPERATURE IS HELD CONSTANT FOR A PERIOD OF FOUR OR FIVE DAYS

FIG. 8—THE COOLING OPERATION REQUIRES ABOUT TWO DAYS BEFORE THE THERMO-COUPLE IS DISCONNECTED

FIG. 9—ANNEALED CASTINGS ARE OFTEN TESTED BY COLD BENDING

the charts of which are conveniently located near the desk of the foundry superintendent as shown in Fig. 6.

The annealing practice of the Arcade Malleable Iron Co. will best be understood by following the entire operation in detail. Although the plant produces fairly large castings, the bulk of its work consists of small parts running from 4 to 10 to the pound. After they come from the initial cleaning operation the castings are sorted for packing.. To avoid warping of small thin parts, it is necessary that they be well packed in the annealing pots. For this reason castings of similar size and design are usually placed together. After the castings have been placed in one of the pots the space around and between them is filled in with mill scale which is treated with red hematite as occasion may demand. The pots, filled with castings and mill scale, are shaken and hammered until the entire contents become a firm, almost solid mass. In fact so tightly pressed together does the mixture of castings and scale become that the bottomless pot may be raised by a chain placed around the outside without dropping the contents. When each tier of four pots is packed it is lifted by the transporting truck and taken into the furnace where it is set in its place. Here thin steel covers are put on and each tier is sealed with fireclay at all joints. The tiers are so placed as to leave an opening about two feet wide along the center of the furnace from front to back. This opening is for the down draft flues which may be seen in the floor, Fig. 3. When the furnace has been completely charged the doors are set in place and the joints sealed up with fireclay. The bungs are made up in sections as shown in the illustration, each section consisting of a steel frame filled with firebrick. In order to facilitate the handling of these doors an overhead rail with traveling chain block is provided.

As soon as the furnace has been completely filled and sealed, fires are started in all four of the fireboxes. The chart, Fig. 5, shows the temperature curve from the start. From this it will be seen that it takes over 36 hours before the oven is brought to the desired temperature. After attaining this temperature, the oven is held at as nearly a uniform heat as possible for a period of four or five days. The chart, Fig. 7, shows the uniform temperature maintained in the oven after the maximum degree has been reached. The curve in this chart covers a period of nearly two days, and the variation of

temperature during this time is hardly sufficient to be recorded by the instrument. The cooling curve is shown in the chart, Fig. 8. This, as may be seen, requires about two days, so the entire annealing operation takes from nine to 10 days from the time the furnace is charged until the castings are removed after annealing and sent to the cleaning room.

*Cleaning and Sorting*

After the pots are removed from the furnace, they are lifted up one at a time by a chain placed around the outside of the pot and are then swung over a dumping space on the floor. As each pot is held over this space it is struck with a hammer until its contents are loosened sufficiently to drop out. The castings and mill scale packing all drop together in a heap from which the castings are raked out and taken to the cleaning room for the final cleaning operation. After being cleaned, the castings are sent to the shipping room for sorting, weighing, and packing for shipment. Fig. 11 shows a mass of the usual run of castings just after they have arrived in the shipping room. The weighing of the castings before shipment has been reduced to a simple operation. A direct-reading platform scale shows the total weight almost instantly when the loaded truck reaches it. Trucks of exactly uniform tare are used so that the weigher is able to keep accurate account of castings about as rapidly as they can be trucked from the sorting benches to the shipping room. This simplification in weighing is one of many innovations brought about under the direction of H. L. Blumenauer who recently took over the management of the plant. One feature which is planned for early application to the annealing operation is a simplified method of separating the castings from the mill scale after they are dumped from the annealing pots. It is the intention to dump on some form of traveling grate or chain which will automatically carry off the castings and let the mill scale drop through into a bin below.

The castings after being annealed in the new furnace have stood up remarkably well under testing and have in every way verified the contention that an absolutely uniform temperature is invaluable in the annealing of small castings. The card reproduced in Fig. 10 shows an average analysis of a casting which is to be annealed. Fig. 9 shows the results obtained with this grade of iron after annealing.

ANALYSIS OF IRON #1 Shop. June 2, 1920.
CAR NUMBER REPORTED June 3, 1920.
FOR Arcade Malleable Iron Co.

| SILICON | SULPHUR | MANGANESE | PHOSPHORUS |
|---|---|---|---|
| .80% | .064% | .34% | |

| TOTAL CARBON | COMBINED CARBON | GRAPHITIC CARBON |
|---|---|---|
| 2.80% | | |

SAUNDERS & FRANKLIN
OFFICIAL CHEMISTS
NEW ENGLAND FOUNDRYMEN'S ASSOCIATION
184 WHITTIER AVE.
PROVIDENCE, R. I
SIGNED G. F. W. Jr.
ANALYSIS NO. 4539

FIG. 10—SAMPLES OF EACH HEAT ARE SENT TO AN OUTSIDE CHEMICAL LABORATORY FOR ANALYSIS. THE RESULTS ARE TELEGRAPHED AND LATER CONFIRMED BY MAIL

*Flues In The Floor*

In the normal operation of the furnace, the fireboxes are filled twice a day with approximately 500 pounds of anthracite coal to each box. In a recent test nine tons of anthracite were used to anneal 35 tons of castings, or approximately four tons of castings to each ton of coal. The circuit of the gases from the fires is up and along the top of the oven from each side to the center, then down the center and through the flues in the floor. Each floor opening is connected to a channel flue which runs under the floor from the center to the side of the furnace and back to the center again where it drops down into a large central flue connected with the chimney at the rear. There are 14 openings on the floor, each 7 x 7 inches. The flues under the floor are also approximately 7 x 7 inches in section and occupy all of the space under the floor except for 4-inch brick walls which separate the flues and which form the support for the tile used for the floor. The chimney is 100 feet high and affords ample draft for the operation of the oven. Except for the floor the entire oven is lined with firebrick.

The arch which consists of one row of firebrick on edge was built on a wooden form and then becomes self supporting. The rise of the arch from side to center is 3 feet and the thrust is taken by steel tie plates and rods. More detailed dimensions of the furnace are shown in Fig. 2 which is a cross section through the fireboxes. The foundation which is usually heavy is of concrete and has been designed to prevent the possibility of cracking. Mr. Jordan was given entire freedom in the construction of this oven and the results, shown not only by the uniform temperature charts, but by the low consumption of coal and the high malleability of the castings produced, testify to what can be accomplished with an oven of this design.

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The Automotive Foundry Co., La-Crosse, Wis., recently has started opation under supervision of T. G. Stewart, superintendent.

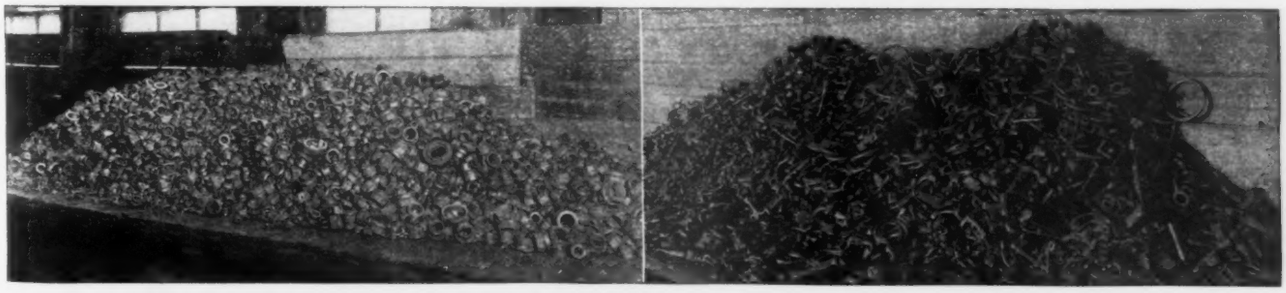


FIG. 11—THOUSANDS OF SMALL CASTINGS ARE MADE FROM A TON OF METAL—UNIONS AND COUPLINGS SHOWN TO THE LEFT, ARE A PART OF THE REGULAR OUTPUT OF THE FOUNDRY

# Judging Sands for Foundry Use-II

## Attributes Which Give Bond to Sand Are Discussed—Plasticity and Colloidal Matter Exert Interdependent Influence —Bond Governs Absorption Power

BY HENRY B. HANLEY AND HERBERT R. SIMONDS

AS THE bond of molding sand is its most important property it is important for foundrymen to understand just what this property really means. The bond of sand in addition to its direct bearing on plasticity also is the most influential factor in estimating the sand's life and refractoriness. A slight variation in the physical condition of a sand may alter greatly the bonding properties and thus shipments from practically the same locality often vary widely in bond. For many years the bond of molding sand was supposed to be dependent upon clay and in reporting the amount of bonding material present as determined by mechanical analysis, the amount of clay substance often has been given. However, it has been found more recently that two sands of widely different bonding qualities may show by analysis the same percentage of clay substance, and this has indicated that it is not the percentage of clay present in a sand which gives the apparent bond, the feel on tempering with water, but that it is due rather to the physical condition of the clay substance itself. That such is the actual case has been borne out by recent investigation. A variation in the colloidal condition of the clay substance is in reality the cause of the variation of bond.

The term colloidal has not a good substitute and its meaning must be understood before any detailed account of the general property of bond can be made. A colloidal condition simply refers to a degree in the size of particles in a substance. It may be thought of as pulverization carried to a greater degree of fineness than is ordinarily considered. A mixture of water with a substance in a colloidal state will form a stable fluid, that is, the particles will not settle out, or at least will do so with extreme slowness. However, the mixture is not a solution in the correct use of the term, for no chemical change has taken place, the particles have not dissolved. They are held in permanent suspension due to their extreme minuteness. Such small particles have several properties peculiar to their state, among which is that of adsorption of certain dye substances. Here again a term must be defined. Adsorption as distinguished from absorption is the property of attracting to the surface of each minute particle a thin film of a substance, without altering the chemical composition of either component. The bearing of all this upon the subject of bond in molding sand is that by means of the characteristics of colloidals the relative value of the bonding properties of different sands is obtained. All of the substances present in the bond of molding sand can exist in a colloidal condition and be in a state of equilibrium.

### *Bond and Plasticity*

Any extended theoretical discussion concerning colloidal properties in general is beyond the scope of the present series of articles. However, inasmuch as it is generally recognized that plasticity and colloidal matter are interdependent, one upon the other, it is necessary to show the relation between these two properties. Several investigators have published results dealing with the bond adsorption of molding sands in an effort to show that the bond might be rated according to the amount of dyestuff removed from solution. This work immediately indicated that great possibilities exist along this line. However, the work in most cases has been carried on with little consideration for the nature of the substances which remove the dyestuff. The assumption has been that different substances absorb the same dyestuff in direct proportion to their quantity or total mass, whereas the fact is that varying colloidals have varying abilities for removing dyestuffs from aqueous solutions. Colloidal matter of gelatinous character is capable of removing noncolloidal dyestuff. This much is certain and is easily demonstrated, but the relative capacity of any one particular colloidal for removing a definite dyestuff is a much more difficult matter to determine. In fact, many investigators at present are working and puzzling over this phase of the situation, and while much is now known, there still is a great deal which is not known along this line.

After examining a great number of sands, particularly in respect to the chemical composition of the bond, it has been shown that the bond of natural molding sands is not in all cases due to clay as the composition, hydrated aluminum silicate is ordinarily termed. On the other hand the majority of the well bonded molding sands of this country owe their bonding qualities to the presence of colloidal, hydrated ferric-oxide. In the study of many sands, surprising results are obtained in connection with the effect of iron oxide on the bonding property.

This is especially evident in the case of New Jersey, New York, and Illinois sands where the relation between alumina ($Al_2O_3$) and iron oxide ($Fe_2O_3$) clearly shows the effect of these oxides upon the bond. In these sands it is safe to say that the bond is not strictly clayey material but that iron oxide is an important factor. This brings in the question of refractoriness in connection with the composition of the bonding substance. In general, good bond properties point to low grade fire clays, and therefore a strongly bonded natural sand may be said to be a poor refractory sand.

Just what composes the clay substance in molding sand is not generally understood, and the following analyses of three typical sands may serve to clear up this point. The tests were made in each case on the bonding material after its separation from the sand:

| | New Jersey Sand | Ohio Sand | New York Sand |
|---|---|---|---|
| Silica | 41.70% | 33.65% | 38.88% |
| Iron Oxide | 14.37% | 28.88% | 24.67% |
| Alumina | 25.40% | 18.15% | 22.50% |

The method of separating the bonding substance for the purpose of the above analyses was what is known as the defocculation process. This has been described in a previous paper and consists briefly in treating the sand with a suitable alkaline solution which breaks the cohesion between the granular material and the colloidal matter, and thus allows the former to settle out, after which the colloidal matter is decanted off.

If the bond of molding sand was composed entirely of clay, either in colloidal or noncolloidal condition, we should not find any such amount of iron oxide as shown in the above table. In the study of molding sands

it is invaluable to know something concerning the amount of bonding material or more exactly the colloidal matter which is present. The bond adsorption determination is the best test for this purpose. The results of such a test prove of great value in mixing strong and weak sands together. For most practical considerations this test is sufficiently accurate, as the normal colloidal material in any two sands has approximately the same power of adsorbing dyestuff. A series of tests on samples of typical sands from various districts is given in the accompanying table. The right hand column gives a close approximation of the relative weights of colloidal matter in the different samples.

As yet no standard method of reporting the percentage of colloidal matter present has been reached. For all practical purposes the comparative amounts of dyestuffs removed from solution gives sufficient information. By comparing such amounts with known qualities of sands, a working table might be compiled. For instance a molding sand that will remove 1000 milligrams of dye from solution for every 100 grams of sand in the sample is generally regarded as plastic, strong bond, molding sand. With this value it will never be nonplastic unless the sand is extremely fine grained. Sands showing a bond adsorption value of 2000 to 3000 milligrams under the same conditions always have great bonding strength. However, the converse of this is not always true. A comparatively low bond adsorption value is not a positive indication of low bonding property. That is, a sand with an ideal combination in grain size may possess a bond adsorption from 150 to 1000 milligrams and yet may be a well bonded sand.

Another phase of the bond problem is the effect of having the bond composed largely of clay substance in the strict sense of the word. Fire clays as ordinarily used in foundries are not regarded as plastic clays, although some of them show decided plasticity and good bonding qualities. Many foundrymen have had shipments of red fire clay and have probably noticed it has more bonding strength and stickiness than the usual white fire clay. This is due to the fact that the red clay contains hydrated iron oxide colloidal matter. In fact it may be said that without this colloidal matter fire clay will be gray or white and will have relatively poor bonding properties.

In recent years fire clay and molding sand have been mixed in an attempt to reclaim old sand. The work in most cases has been unsuccessful, especially in producing a sand which feels as it should. Here again, the cause has been the absence of hydrated ferric oxide, and after exhaustive tests it can be safely said that no blend made artificially exactly equals the feeling of a natural sand mixture. This is undoubtedly because of the difficulty in duplicating the actual composition of the bonding substance found in nature. Perhaps the nearest approach to this is reached by selecting an extremely plastic clay composed of colloidal clay substance and organic colloids and of mixing this with old or sharp sand. This blend will produce castings of excellent appearance and will work well in both dry and green sand molding.

Mixtures of this kind have been used extensively in foundry work but care must be taken in handling them as they are more sensitive to venting than routine mixtures in every day use. The question of composition of colloidal substance has an important bearing on the action of heat on sands. It is largely, behavior under heat action which determines the longevity of one sand as compared with another, and the proper consideration of colloidal composition with respect to heat resistance offers a greater opportunity for economy in the use of certain molding sands than does any other phase. A sand containing a large amount of colloidal hydrated iron oxide will also show a high bond adsorption value because the iron colloids have a great capacity for adsorbing dyestuff. Such a sand is found in New Jersey, and always has been known as strong in bond. However, any foundryman using this sand knows that its life is short. The reason is clear; the action of the heat on the colloidal matter has broken it down because of the excessive amount of iron oxide present.

The first layer in the mold, consisting of about 1 inch of sand next to the casting, has been seriously dehydrated, the next layer has been partly dehydrated, and the remainder of the sand back to the flask has been sufficiently heated to change slightly the physical properties of the colloids. Thus the ultimate bond of every part of the sand in the mold has been altered, and as a matter of fact weakened. Take for example the case of a cylinder casting weighing approximately 1000 pounds. The details of the change in bond during casting in an actual test are as follows:

The first layer of sand lost practically all its colloidal property, the proper feel of this portion of the sand when tempered with water had entirely disappeared and the sand became coarser and had a changed color.

If the facing sand is new it will change from yellow or from yellowish

## TABLE I

## Relative Amounts of Collidial Matter in Sands

| No. | Molding Sand from | Grade of Sand | Bond Adsorption Value* |
|---|---|---|---|
| 1 | Pennsylvania | Fine | 1260 |
| 2 | Pennsylvania | Fine | 488 |
| 3 | Pennsylvania | Medium | 408 |
| 4 | Pennsylvania | Fine | 400 |
| 5 | Pennsylvania | Medium | 630 |
| 6 | Pennsylvania | Coarse | 2800 |
| 1 | Kentucky | Exceedingly fine | 2280 |
| 2 | Kentucky | Exceedingly fine | 1160 |
| 3 | Kentucky | Medium | 1880 |
| 4 | Kentucky | Fine | 700 |
| 5 | Kentucky | Medium | 2760 |
| 6 | Kentucky | Fine | 3320 |
| 1 | Tennessee | Fine | 1040 |
| 2 | Tennessee | Medium | 1080 |
| 1 | Ohio | Fine | 810 |
| 2 | Ohio | Fine | 1320 |
| 3 | Ohio | Medium | 2360 |
| 4 | Ohio | Medium | 1620 |
| 5 | Ohio | Medium | 650 |
| 6 | Ohio | Coarse | 1180 |
| 1 | New York | Fine | 215 |
| 2 | New York | Medium | 210 |
| 3 | New York | Medium | 175 |
| 4 | New York | Medium | 426 |
| 5 | New York | Coarse | 272 |
| 6 | New York | Fine | 304 |
| 1 | Missouri | Very fine | 1260 |
| 2 | Missouri | Medium | 296 |
| 3 | Missouri | Medium | 1880 |
| 4 | Missouri | Fine | 1920 |
| 5 | Missouri | Coarse | 2600 |
| 6 | Missouri | Fine | 3240 |
| 1 | Illinois | Medium | 1960 |
| 1 | New Jersey | Coarse | 263 |
| 2 | New Jersey | Medium | 460 |
| 3 | New Jersey | Medium | 400 |
| 4 | New Jersey | Medium | 810 |
| 5 | New Jersey | Coarse | 1520 |

*Figures given represent number of milligrams of dyestuff adsorbed from solution by 100 grams of sand.

red to a deep red color throughout.

The second layer of sand including that between the first and third inch from the casting showed a decided loss of bonding quality, and the sand became slightly gritty.

The last portion of the sand extending to the flask was not greatly effected though even here a change was noted.

The longer the sand remains in the flask the greater the deterioration, so that economies often are made by dumping out the work as soon as consistent with good foundry practice. Some of the literature on this topic is misleading for the bond generally has been regarded refractory and not at all affected by comparatively low temperatures. In reality it is difficult to find a natural molding sand in which the bond is not seriously affected by the temperatures of usual foundry practice. The best bonded sands in the United States will lose the greater part of their strength if they are kept in a temperature zone of 1000 degrees Fahr. for a sufficiently long time.

When the bond of a sand is altered by action of heat, the colloidal substance present also is altered and the plasticity of the sand suffers. It is possible to change the colloidal substance back to its original condition but this requires more time and more extensive treatment than it is advisable for foundries to give. To understand the destruction of colloids it is important first to investigate the actual loss in strength due to such destruction. In a typical example taken, the bonding strength of the original sand used in the flask for facing and backing measured, in transverse strength before pouring, 680 ounces per square inch. After pouring the casting, samples of the same sand in the first layer next to the casting were mixed and tempered with water. These showed a bonding strength under similar transverse test of but 5 ounces per square inch. The second layer of sand from 2 to 3 inches away from the casting, when mixed and tempered with water after the pouring showed a transverse strength of 150 ounces per square inch. The third layer of sand near the outside of the flask developed 600 ounces per square inch under the same test. The first layer of sand in this case was absolutely useless and if mixed with other molding sand simply would reduce the strength of the whole and accomplish no good. The second layer of sand which showed a strength of 150 ounces per square inch might have been appreciably rejuvenated by mixing with water, and by then allowing it to stand before using. The third layer of sand was so little altered that the general handling would have mixed it sufficiently for further use. The discussion so far has been on the assumption that the process of molding was carried on with green sand.

In dry sand work, more heat penetrates through the sand than with green sand operations, and when the same experiments are conducted for comparative results it will be found that there is considerable less loss due to the action of heat in green sand casting than in dry sand work. Colloidal hydrated aluminum silicate or in other words, clay, will not be dehydrated or lose its bonding strength as quickly by the action of the heat as colloidal hydrated iron oxide. However as already mentioned, few natural sands contain clay as a predominating colloid, and therefore it is the hydrated iron oxide colloids which are dealt with most commonly.

The bond present in a molding sand has some influence upon the water absorption of the sand. In this connection experiments have been undertaken with a view to ascertaining what percentage of water would be observed by the sands from different localities having widely separated bond properties. Table II gives the results of these experiments and from this analysis it may be seen that in the normal case sands carrying bonds composed of a clayey and ferruginous substances readily absorb water, and that the more the sands incline toward a ferruginous bond the greater the power of absorption becomes. These sands of high absorbing power are in popular use in many foundries and examinations will show them to be capable of carrying large amounts of water without actually feeling wet. This capacity for absorbing water is a physical property possessed by colloidal hydrated ferric oxide, and by other colloidal substances. The percentage of water in the table has been determined by adding water to dry sand up to the point of its saturation. Therefore it does not mean the percentage of water which the sand might carry for molding purposes. However, the table furnishes a means for comparing the physical condition of the colloidal substances present in the sand.

The treatment of bond in molding sands from the colloidal standpoint offers greater possibilities than any other method. A low bond adsorption value say from 200 to 400 clearly indicates a weaker sand than where the value is 800 or above. A sand with a bond adsorption value of 1000 or more may be mixed economically with weak sands and to good advantage. Sands with a high percentage of ferruginous bond always are more sticky and velvety than those of a clayey character, but do not possess the heat resisting power of the clayey bonded sands. In spite of this, sands of ferruginous bond are excellent for molding and are popular with most foundrymen through possessing this quality.

## TABLE II

## Relation of Absorption to Bond in Sands

| No. | Sand | Water Absorption Percentage | Apparent Bond | Nature of Bond |
|---|---|---|---|---|
| 1 | Pennsylvania | 25 | Plastic and sticky | Mostly ferruginous |
| 2 | Pennsylvania | 20 | Nonplastic | Clayey |
| 3 | Pennsylvania | 18 | Fairly plastic | Clayey |
| 4 | Pennsylvania | 25 | Exceedingly plastic and sticky | Mostly ferruginous |
| 5 | Pennsylvania | 20 | Plastic and sticky | Mostly ferruginous |
| 6 | Pennsylvania | 18 | Nonplastic | Clayey |
| 1 | Kentucky | 20 | Plastic and sticky | Mostly ferruginous |
| 2 | Kentucky | 20 | Nonplastic | Clayey |
| 3 | Kentucky | 15 | Fairly plastic | Clayey and ferruginous |
| 4 | Kentucky | 24 | Plastic and sticky | Mostly ferruginous |
| 5 | Kentucky | 19 | Nonplastic | Clayey and ferruginous |
| 6 | Kentucky | 21 | Plastic and sticky | Mostly ferruginous |
| 1 | Tennessee | 23 | Exceedingly plastic and sticky | Mostly ferruginous |
| 2 | Tennessee | 20 | Exceedingly plastic and sticky | Mostly ferruginous |
| 1 | Ohio | 25 | Plastic and sticky | Mostly ferruginous |
| 2 | Ohio | 19 | Plastic and sticky | Clayey and ferruginous |
| 3 | Ohio | 20 | Plastic and sticky | Mostly ferruginous |
| 4 | Ohio | 12 | Nonplastic | Clayey |
| 5 | Ohio | 17 | Plastic and sticky | Mostly ferruginous |
| 6 | Ohio | 20 | Plastic | Clayey |
| 1 | New York | 20 | Nonplastic | Clayey and ferruginous |
| 2 | New York | 18 | Nonplastic | Clayey and ferruginous |
| 3 | New York | 14 | Nonplastic | Clayey and ferruginous |
| 4 | New York | 21 | Nonplastic | Clayey |
| 5 | New York | 18 | Nonplastic | Clayey |
| 1 | Missouri | 27 | Plastic and sticky | Mostly ferruginous |
| 2 | Missouri | 14 | Nonplastic | Clayey and ferruginous |
| 3 | Missouri | 17 | Plastic and sticky | Mostly ferruginous |
| 4 | Missouri | 22 | Plastic and sticky | Mostly ferruginous |
| 1 | Illinois | 24 | Plastic and sticky | Mostly ferruginous |
| 1 | New Jersey | 9 | Nonplastic | Clayey |
| 2 | New Jersey | 14 | Plastic | Clayey |
| 3 | New Jersey | 19 | Plastic and sticky | Clayey and ferruginous |
| 4 | New Jersey | 16 | Plastic and sticky | Mostly ferruginous |

# Direct Current Used for Furnace

## Application to Steel Melting Has Been Successful—Scrap is Charged and Permitted to Stand in the Sealed Furnace Over Night to Bring It to a Dull Red Heat

BY CARL REED

SO MUCH controversy has been raised on the possibility of successfully operating an electric melting furnace with direct current, that the writer believes his experience would be of interest along this line. For the past year he has been in charge of a foundry in which good steel castings were being made with a melting unit operating on direct current. The furnace is of the opening-roof type, manufactured by the Industrial Electric Furnace Co., Chicago. It is in operation at the Oil City plant of the Oil Well Supply Co., Pittsburgh, and is similar to that shown in the accompanying illustration.

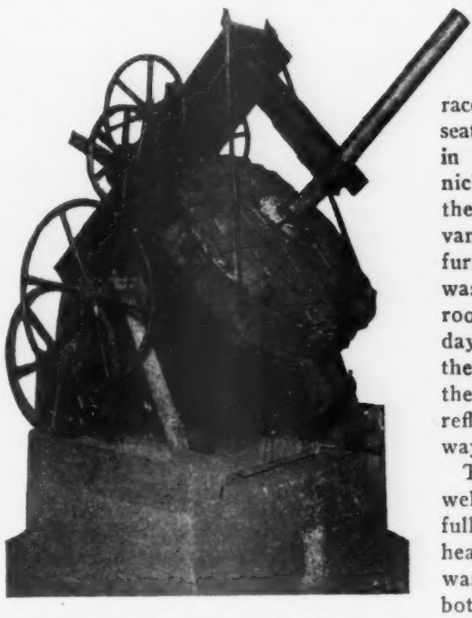
The current was supplied from the power plant of the Oil Well Supply Co. The other power requirements of the plant were so heavy that it was impossible to allow more than 1200-amperes for the electric furnace. In order to operate the furnace, it was necessary to have external resistance in the form of a water pipe rheostat to reduce the voltage in proportion to the increase in the flow of current.

This furnace operated on 60 per cent of the voltage of the line for about the first 10 minutes, when cold, then up to 75 per cent for about 30 minutes, and then ran 84 per cent of the line voltage until the heat was finished, so that the voltage of the arc went up to 200, with 1200 amperes.

Graphite electrodes were used. A 4-inch electrode weighing 27 pounds lasted 9 to 11 heats on the average, making a consumption of approximately three pounds per heat, or four pounds per ton of metal melted. The positive side of the generator was connected to the top electrode and the hearth of the furnace was connected to the negative side and grounded. The electrical connection in the hearth consisted of a piece of 1¼-inch cold-rolled shafting, cooled by a brass water box outside of the furnace.

The normal capacity of the furnace was 1250 pounds, although the heats averaged between 1400 and 1500 pounds. With the power available it was possible to obtain up to six heats in 14 hours, and the kilowatt-hour consumption including external resistance losses, was approximately 700 kilowatt-hours per heat. When the furnace was hot, 1500-pound heats could be completed in 2 hours and 15 minutes. Over 700 heats were run in the past year and the number would have been even larger if it had not been for trouble in the power plant which interfered with the supply of power. Castings as large as 1300 pounds were made from this furnace.

In this work it was found that one of the important elements of the success of the direct current operation consisted in having the scrap hot. In order to accomplish this the furnace was recharged immediately after the last heat of the day was poured. The spout and the space around the electrode were then carefully sealed so that the next morning the scrap would be a dull red. This made the arc very much steadier when starting the furnace than it would have been had the charge been cold.



TYPE OF FURNACE USED WITH DIRECT CURRENT FOR MAKING STEEL CASTINGS

Another problem that arose was that of oxides in the steel. These were removed by maintaining a deoxidizing slag on top of the metal. No more ferrosilicon or aluminum was used for killing metal than is used in alternating-current electric furnace operation. The melting stock consisted of foundry heads and gates, machine shop turnings, old bolts, flashings from the forge shop and, in fact, the usual class of scrap used in most electric-steel foundries. About four pounds of ferrosilicon, ½ pound of aluminum and 6 pounds of ferromanganese were used per heat. Coke and lime were used on the slag to prevent oxidation of the metal—about five pounds of coke and a handful of lime per heat. The coke and lime were not put in until the metal, so far as temperature was concerned, was ready to pour. Several heats of 3½ per cent nickel steel have been made successfully. This material was used for ball-bearing race ways and for slotter bars for key-seating machines. The steel was made in the regular way with 3½ per cent nicket shot that was added cold with the charge. From 75 to 80 heats of vanadium steel also were made in this furnace. When roofs were changed, it was found advisable to put the new roof on the furnace at the end of a day. Then the new roof would get the greater part of its expansion before the intense heat of the arc would be reflected against it. Roofs put on this way have lasted through 300 heats.

The bottoms on the furnace lasted well. When the bottoms were carefully put in, they lasted from 50 to 75 heats without any repairs, but if there was any clay in the ganister, or if the bottom was put in hurriedly, it would need patching after about 20 heats were run. Usually, the furnace was allowed to cool at the end of each week so that a careful investigation could be made and any possible holes which were started could be filled. The present lining has lasted more than six months and still is in good condition. No patching of any consequence has been done on this lining since it was put in except that the arch over the spout has been replaced once.

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Incorporated under the laws of Delaware with a capital of $100,000, the Mount Holly Foundry Co., Mount Holly, N. J., will produce machine molded gray iron castings weighing up to 100 pounds. It has leased the plant of the former Risdon-Alcott Turbine Co., and will install modern machinery and equipment, most of which has been selected. Lewis R. Palmer is president and George C. Palmer is secretary and treasurer.

# Self Annealing in Aluminum Bronze

## Large Castings Acquire Coarse Structure when Allowed to Cool Slowly—Modification of Composition, Pouring Cold and Spraying with Water Prevent This—Heat Treatment Strengthens the Metal

BY AUSTIN B. WILSON

IT IS only with considerable difficulty that it has been possible to produce large castings of aluminum bronze, of about 10 per cent aluminum, with suitable physical properties. Frequently small castings have been made at the same time with larger castings and the smaller castings have been satisfactory while the larger pieces have fallen far short of the normal qualities for this material. This phenomenon is due to what is known as self-annealing. Owing to the large cross-section of heavy casting the metal cools slowly and consequently a coarse structure is produced. This in itself would be bad enough but there is another result far more serious. This is described later.

The author, Austin B. Wilson, is metallographist, the Titanium Alloy Mfg. Co., Niagara Falls, N. Y.

For comparative purposes a photomicrograph of normal sand-cast ten per cent aluminum bronze is given in Fig. 1. This will be seen to consist of light-colored alpha and darker beta grains. The properties of this material are approximately as follows:

| | |
|---|---|
| Yield point, lbs. per sq. in. | 2400 |
| Tensile strength, lbs. per sq. in. | 7000 |
| Elongation, per cent | 20.0 |
| Reduction of area, per cent | 21.0 |
| Brinell hardness | 100 |

In aluminum bronze which has undergone self-annealing the extraordinarily large alpha grains are accom-

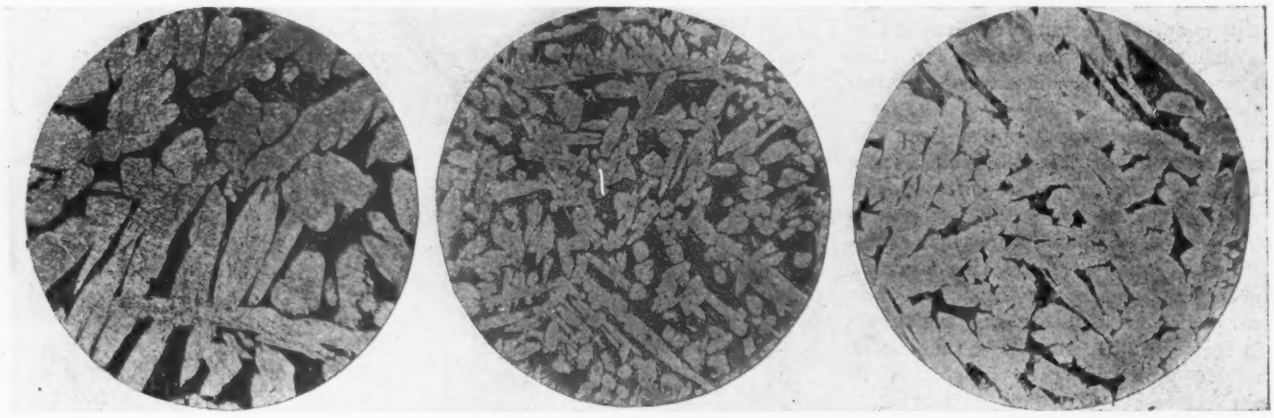


FIG. 1—NORMAL STRUCTURE OF ALUMINUM BRONZE, AS CAST, LIGHT ALPHA AND DARK BETA—MAGNIFIED 200 DIAMETERS FIG. 2—STRUCTURE OF BAR NO. 1 SHOWING THE BETA ALL IN THE GRAYISH ANNEALED FORM—MAGNIFIED 20 DIAMETERS FIG. 3—STRUCTURE OF BAR NO. 2 SHOWING LESS BETA THAN FIG. 2—MAGNIFIED 20 DIAMETERS—NOTE PART OF THE BETA IS IN THE NORMAL (DARK) CONDITION. ALL ETCHED WITH FERRIC CHLORIDE

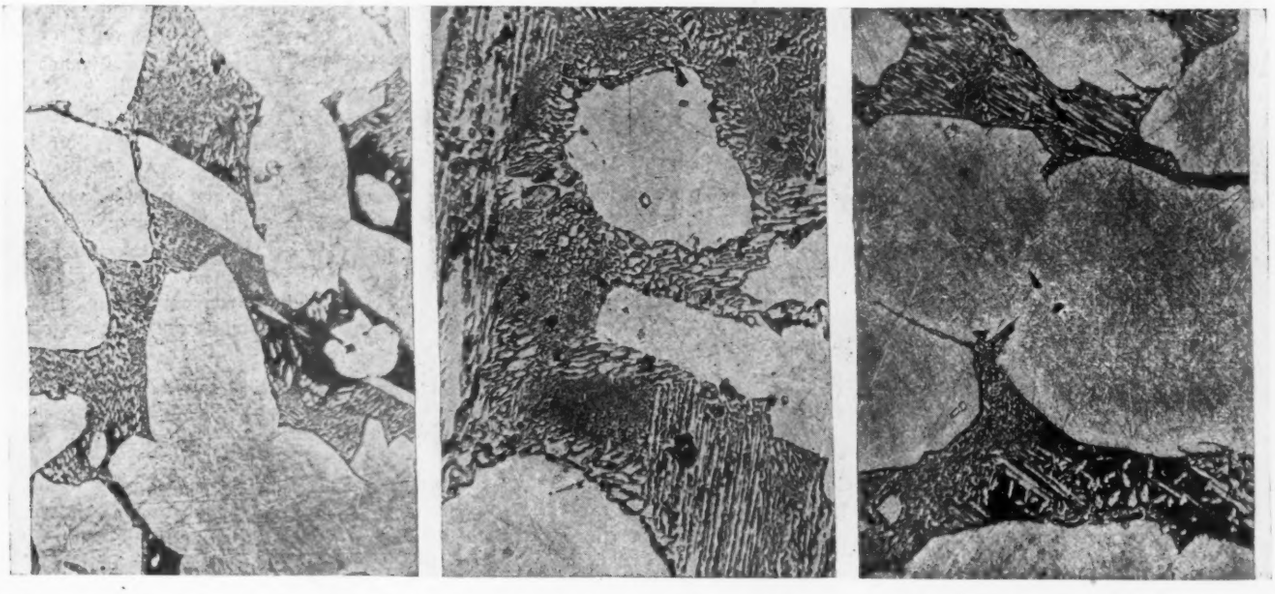


FIG. 4—STRUCTURE OF BAR NO. 3 SHOWING MORE NORMAL AND LESS ANNEALED BETA THAN EITHER FIG. 5 OR 6 FIG. 5—STRUCTURE OR BAR NO. 1 SHOWING COARSELY LAMELLAR BETA AND LIGHT ALPHA GRAINS—MAGNIFIED 200 DIAMETERS FIG. 6—STRUCTURE OF BAR NO. 2 SHOWING COARSE ALPHA GRAINS AND THE BETA PARTLY IN THE GRAYISH LAMELLAR FORM AND PARTLY IN THE NORMAL (DARKER) CONDITION—MAGNIFIED 200 DIAMETERS—ALL ETCHED WITH FERRIC CHLORIDE

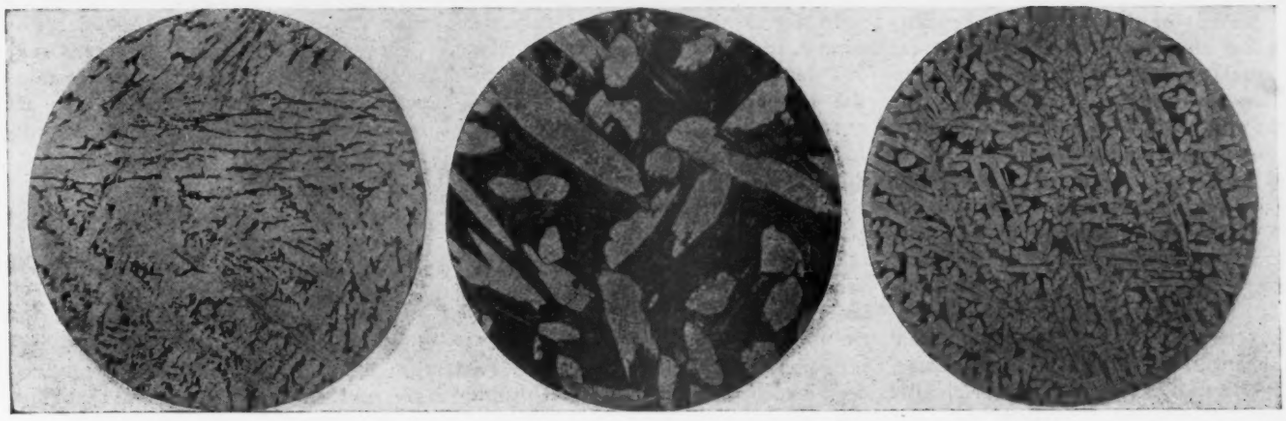


FIG. 7—STRUCTURE OF BAR NO. 3 SHOWING FINER GRAIN THAN EITHER FIG. 1 OR 2, ALSO MORE OF THE BETA IN THE NORMAL (DARK) CONDITION—MAGNIFIED 20 DIAMETERS FIG. 8—NORMAL STRUCTURE OF ALUMINUM BRONZE AFTER AIR-COOLING FROM 900 DEGREES CENT., ALPHA-BETA STRUCTURE VERY SIMILAR TO FIG. 1, BUT WITH LESS ALPHA DUE TO MORE RAPID COOLING FIG. 9—TYPICAL ALPHA-DELTA STRUCTURE OF LARGE CASTING AFTER DOUBLE HEAT TREATMENT—MAGNIFIED 200 DIAMETERS—ALL ETCHED WITH FERRIC CHLORIDE

panied by a coarsely lamellar beta constituent similar to lamellar pearlite in steel, that is, the beta has broken down into its two components, alpha and delta. Some writers say that the beta is never really beta, but only apparent beta, or in other words, that if a high enough magnification is used the beta can always be resolved into its constituents. However, the fact remains that the structure just described is always accompanied by excessive brittleness and weakness.

Recently some good examples of this self-annealing have come to the writer's attention in an alloy of 10 per cent aluminum, 1 per cent iron and 89 per cent copper. Several large screw-down nuts in use on the rolls of a steel mill failed while in service. The trouble occurred in the threads which wore and broke. One member of the mechanical department said they were too soft, another that they were too hard and brittle. This was thought rather odd, so a complete investigation was decided upon. Both were subsequently shown to be right.

Tensile and compression test pieces were cut from near the threads of three of the failed nuts. The compression test pieces were analyzed after being tested, and hardness tests and microscopic examinations were made on the ends of the broken tensile test bars. The results are shown in the accompanying table.

As would be expected, the fractures of the tensile test bars showed differences which checked with the results obtained in testing. This is illustrated by Figs. 2, 3 and 4, which show micrographs at 20 diameters of bars Nos. 1, 2 and 3, respectively. Bar No. 1 showed a coarse grain and the grayish fracture typical of annealed aluminum bronze. On comparing Fig. 2 with Fig. 1, the reason for this will at once be apparent. In Fig. 2 the beta constituent, normally very dark as in Fig. 1, is colored a light gray due to being broken down into its two constituents described. The fracture of bar No. 2 was as coarse as the fracture of bar No. 1, but less grayish. Fig. 3 shows the alpha grains slightly larger due the lower aluminum content but it also shows the beta to be less in the annealed form, and so more nearly normal. Bar No. 3 was shown by the fracture to be finer grained than either of the others and intermediate in grayness. The structure, Fig. 7, of this bar was fair but there was still considerable of the grayish eutectoid present.

The bars were then examined at a higher magnification and their microstructures were found to differ greatly. Nevertheless, they all were found to contain too much of the coarsely lamellar beta eutectoid characteristic of brittle and self-annealed metal. Eutectoid in the lamellar form should not be present in normal castings. In Fig. 5, representing bar No. 1, the eutectoid is seen to be all in this grayish form. Fig 6, illustrating the structure of bar No. 2, shows coarse alpha grains and a little normal eutectoid, dark after etching, but also considerably of the grayish eutectoid. Fig. 4, bar No. 3, shows a generally coarse structure with considerably more of the normal beta (dark) but even here too much of the grayish eutectoid is present. Bar No. 3 should have given better results in the tests but was found to be slightly unsound.

The cause of the failure of these castings was undoubtedly self-annealing. This, as explained, was due to too slow cooling in the molds. The fact that some were considered too hard and others too soft is readily explained by the difference of 1.15 per cent in the aluminum content of bars Nos. 1 and 2. At approximately 10 per cent aluminum such a difference would be sufficient to cause considerable variation in the physical properties of this class of material.

Practically the only way in which it is possible to discover self-annealing is by microscopic examination. Small lugs could be cast in suitable places on the casting and afterwards cut off, polished and examined. This would prevent any castings in this condition being shipped out and subsequently returned as unsatisfactory.

In order to prevent the occurrence of self-annealing in large castings great care must be exercised. The composition of the alloy may be so modified that the constituents necessary to self-annealing are absent, or some method of cooling more rapidly may be used. With large castings quenching is impracticable, not only

**Results of Tests of Self-Annealed Aluminum Bronze**

| Specimen number | 1 | 2 | 3 |
|---|---|---|---|
| Copper per cent | 88.18 | 89.38 | 88.85 |
| Iron per cent | 1.13 | 1.08 | 1.08 |
| Aluminum (by dif.) per cent | 10.69 | 9.54 | 10.07 |
| Brinell hardness number | 124 | 93 | 109 |
| Yield point, lbs. per sq. inch | 30,600 | 20,300 | 22,700 |
| Tensile strength, lbs. per sq. inch | 56,900 | 52,300 | 55,200 |
| Elongation, per cent | 4.0 | 22.0 | 9.0 |
| Reduction of area, per cent | 5.1 | 22.2 | 11.2 |
| Elsatic limit in compression, lbs. per sq. inch | 22,500 | 20,000 | 20,500 |
| Compression, per cent, after load of 10,000 lbs. per sq. inch | 11.2 | 19.3 | 14.1 |

on account of the weight of the casting but also on account of the severe internal stresses liable to be set up within the casting. Controlling the temperature so that the metal is cast at as low a temperature as possible, and shaking from the mold as soon as the metal has solidified would assist materially in preventing self-annealing. Cooling the casting with a fine spray of water is also resorted to with success. When self-annealing has occurred the metal cannot again be changed so as to have the same properties that it had as originally cast. There are two alternatives to improve the physical properties of the metal. It can be heated to above the critical point and then cooled in air, or it can be doubly heat-treated.

In the former case it is only necessary to heat the casting to about 900 degrees Cent., hold it there, until the temperature is uniform throughout and then withdraw it from the furnace allowing it to cool in air. Fig. 8 shows the typical microstructure resulting from this treatment and although the micrograph shown was taken from a small piece, the structure of a large casting so cooled would be much the same. It is similar to the normal alpha-beta structure shown in Fig. 1. After air-cooling as just described it will have physical properties about as follows:

| | |
|---|---|
| Yield point, lbs. per sq. in. | 23600 |
| Tensile strength, lbs. per sq. in. | 73200 |
| Elongation, per cent | 5.0 |
| Reduction of area, per cent | 9.0 |

When given a double heat-treatment by quenching from 900 degrees Cent., reheating to 650 degrees Cent. and furnace cooling, a large casting should have a microstructure similar to that shown in Fig. 9. Its physical properties would be approximately:

| | |
|---|---|
| Yield point, lbs. per sq. in. | 40800 |
| Tensile strength, lbs. per sq. in. | 85100 |
| Elongation, per cent | 12.5 |
| Reduction of area, per cent | 15.7 |

The result of the double heat-treatment on the microstructure has been to allow the complete breaking down of the beta into alpha and delta, but the temperature has been kept so low and the time so short that the grains have been prevented from coalescing by the rigidity of the metal. The resulting fine alpha-delta structure is indicative of a very strong condition and the metal is ductile.

# How and Why in Brass Founding

By Charles Vickers

## Copper Casting Presents Difficult Problem

*We have poured a large rectangular copper casting, approximately 48 by 57 by 21 inches and weighing about 5000 pounds. Three cores run through the center of the casting leaving walls 1½ inches in thickness. The casting was poured on the side, but owing to a run-out through the bottom the casting was poured short, leaving the top side about 1¼ inches thick, or about 1200 square inches of surface short ¼ inch in thickness. What we wish to learn is: Will it be feasible to build up this thickness by means of burning with hot molten copper from a ladle, and if so, what special means could be employed to facilitate this operation? We would also like to know if there is any special flux that might be used for burning copper. We would greatly appreciate any general directions you may be able to give.*

Copper is especially difficult to "burn in" because it is a very good conductor of heat as well as electricity. In our opinion the cheapest way would be to scrap the casting and make a new one. It would cost more to attempt to burn it than to make another. Copper being such a good conductor of heat it would be necessary to preheat the casting nearly to redness before attempting to burn it; otherwise, the surface of the casting would fail to be melted by the metal poured on. This difficulty of course could be surmounted; then comes the difficulty of getting the new addition of copper without holes; it would be a spongy mass in all probability. This is because the burn would have to be an open one; we fail to see how the casting could be enclosed in a mold and the missing ¼ inch be flowed onto the casting so as to burn in; it could be done on a small casting but not on such a large surface as the one under discussion. If poured in open sand the copper, as before remarked, would be spongy although deoxidized in the same manner as the original casting. The best flux to use is calcined borax.

## Alloy for Razor Backs

*We would like to obtain the formula for a strong white metal suitable for razor backs. The alloy should melt at a low temperature.*

An alloy of aluminum 92 per cent and copper 8 per cent would be suitable if the temperature at which it melts is not too high. The following alloy may possibly be more suitable: Zinc, 72.70 per cent; tin, 19 per cent; copper, 5 per cent; lead, 2 per cent; aluminum, 1 per cent; antimony, 0.30 per cent. To make the alloy, melt 69.20 per cent of zinc and when hot add 7.5 pounds of sheet yellow brass, 2 pounds of lead, 1 pound of aluminum, 5 ounces of antimony and 19 pounds of tin. Stir the alloy thoroughly and pour into ingots. Remelt the ingots for casting purposes.

## Casting Piston Rings in Permanent Molds

*We are making an alloy of 50 per cent copper, 50 per cent lead and are casting into rings for pistons. We use sand molds but to save this expense we would like to learn if it is possible to use cast iron molds, and if so how the molds should be made. The castings are shaped like a crescent.*

We know of no one making these castings by the die casting method, therefore, we are not able to state positively that this alloy can be die cast. There are about a thousand different methods practiced for holding the lead in admixture with the copper after the alloy has solidified, and some of them produce a metal which when chilled will not retain the lead. The first point to determine therefore, is whether your method will hold the lead in rapidly cooled metal, and to this end an iron mold should be rigged up and be tried. If this turns out satisfactory, the metal can be die-cast, and it will then pay to place an order with a professional die-sinker for the molds, and also engage an engineer to design the die machine that will be required to operate the dies. It will be necessary to go to considerable expense in the matter, for both dies and machine will require to be properly designed and built, otherwise, it will be impossible to obtain production, and the die-casting method will be much more expensive than sand casting.

# Gas Engine Shop Has Many Novel Features

By Pat Dwyer

IN THE mind of the ordinary layman a foundry is a low, dark, smelly place in which strong, dirty men manipulate wooden models to form cavities in the sand. In a still more hazy manner the average person is aware that the metal is melted and poured into these cavities to form castings. That a knowledge of countless and endless details, only gained through years of experience, is a necessary part of the mental equipment of those who make castings is not realized, and the fact that the methods, processes, and mechanical equipment to be found in any of our modern foundries show a decided advance over those in vogue a decade or more ago, is not appreciated outside the foundry industry itself. The basic principles of casting metals, of course, remain the same. The molds are made in sand and are destroyed each time they are used, and the metal is melted in a cupola which simply is a melting medium and cannot be employed to effect any metallurgical changes in the iron thrown in at the charging door. The basic principles remain the same and for that reason it may be said that all foundries are alike. However, in the application of these principles, in the adoption of modern and improved processes and equipment, in the design and erection of special types of buildings peculiarly adapted to the production of quantities of duplicate castings are embodied and crystallized the results of years of experience and observation on the part of men who have made a life long and intimate study of the subject.

Consider the new foundry of the Hercules Gas Engine Co., of Evansville, Ind. This is an old established concern, long famous for its product, a constantly increasing volume of business made it necessary materially to enlarge its foundry capacity and since the company's property afforded ample room for expansion it was decided to build an entirely new foundry and equip it in a manner peculiarly adapted to the company's line of business rather than try to enlarge and adapt the existing foundry.

The buildings were designed by and erected under the supervision of Russ & Karges, architects, Indianapolis and Evansville. Clement A. Hardy, Chicago, had charge, as industrial engineer, of selecting and installing the equipment. His work was done in conformity with the ideas of R. J. McSherry, foundry superintendent, who is qualified by long training and experience to have decided views on the subject. Before purchasing and installing the equipment he made an extensive tour of all the latest modern foundries and the result of this tour together with his former knowledge is shown in a plant which apparently is the last word in foundry construction. As may be seen by referring to the illustration, Fig. 3, the new foundry comprises three self-contained units. They all are connected at one end by a gangway 18 feet wide, but each unit is separated

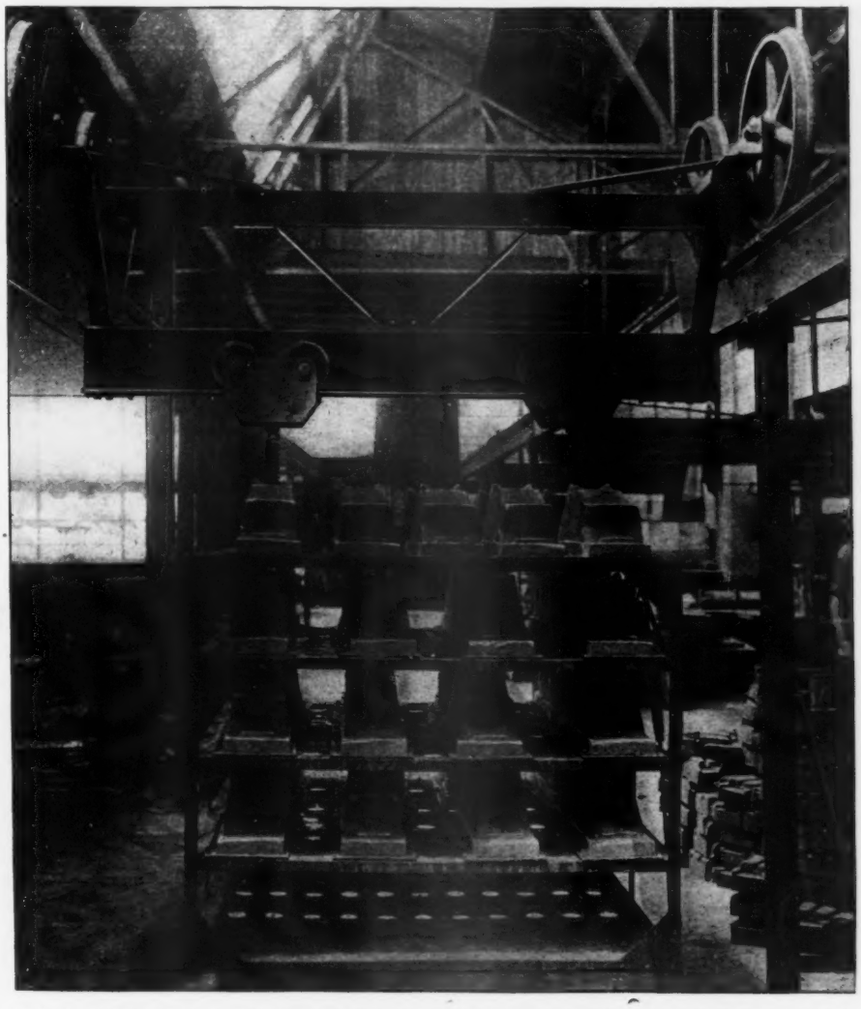


FIG. 1—CORE RACKS REMAIN SUSPENDED ON SPRINGS FROM I-BEAMS BOTH INSIDE AND OUTSIDE THE OVENS—OVERHEAD TRANSFER TRUCKS ARE EMPLOYED TO SHIFT THEM FROM PLACE TO PLACE LATERALLY

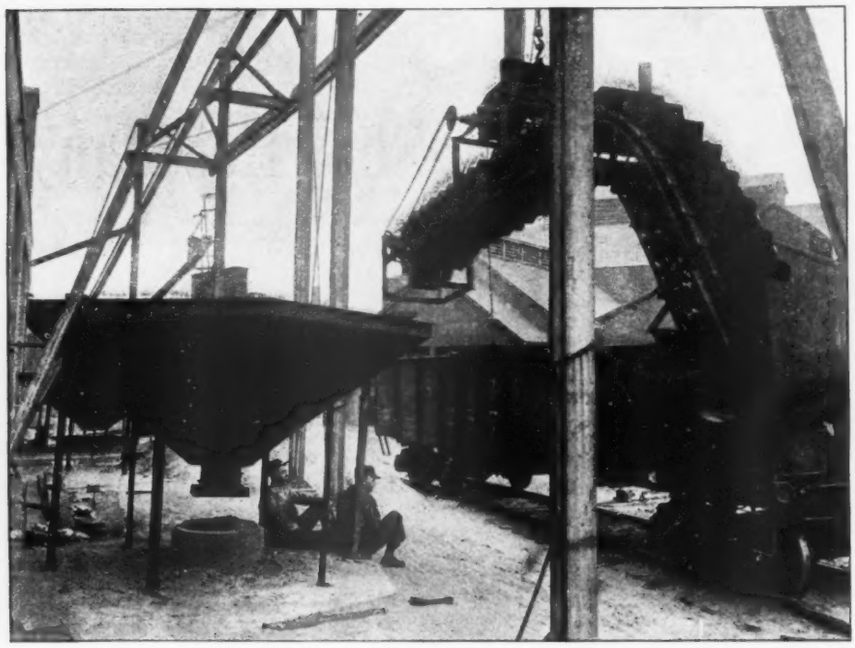


FIG. 2—SAND IS UNLOADED BY A SPECIAL DEVICE WHICH SHOOTS IT THROUGH A HOPPER INTO THE BASEMENT

from the other by court like openings, one 25 x 24 feet and the other 20 x 160 feet. This insures adequate lighting and ventilation facilities. The buildings are the modern factory type construction, single story with steel frame windows and brick walls. The roof is the Pond truss type provided with top hung sash. One section of the sash which forms the greater part of the side and end walls also is hung in the same manner.

Taking the units in regular sequence as they appear on the plan, the first is the main foundry building, 242 x 300 feet, devoted to molding crankcases, bases, fly wheels and miscellaneous castings; the cylinder and piston foundry, 100 x 240 feet, and the core room, approximately 160 feet square with the exception of one corner cut off to conform to the property boundry line.

In addition to the buildings shown on the plan, large roomy basements extend under each one. These are used for core-oven coke, sand and miscellaneous storage purposes. One section under the core room houses the firing room for the core ovens and also the machines and appliances for mixing the core sand.

The different grades of new sand are taken directly from the railroad cars by a mechanical unloader, made by the Daw Iron Works, Louisville, Ky., and dropped into one of the hoppers as shown, in Fig. 2. These hoppers discharge through suitable openings in the basement roof which in this case is the ground level of the foundry yard, onto two belts, one for the molding sand and one for the core sand. The belts are each 26 inches wide and extend approximately 160 feet, or from under the hoppers to the most remote sand bin. Adjustable stops at different points serve to deflect the sand on its passage from the car into the proper bin. A third belt in the basement is employed for conveying coke for the core-oven fires from the cars in which it is received. Each belt is driven by an individual 10-horsepower General Electric motor and as each one is operated independently and only when occasion requires, it is stated that the installation is both efficient and economical.

The main foundry building is divided as shown in Fig. 3. into three molding bays, separated from the cleaning room which extends across the full width of the building, by a brick wall. The work made in these three bays, as nearly as possible, is kept uniform in character, particularly in respect to size and weight. Occasionally it must be changed to harmonize with the general scheme. The time element enters largely into all contracts for castings for the automotive industry and it not infrequently happens that jobs be switched around to make a schedule work out as intended.

The building is equipped with six 5-ton electric cranes made by the Pawling & Harnischfeger Co., Milwaukee, and two 5-ton cranes made by the Whiting Foundry Equipment Co., Harvey, Ill. These cranes do most of the lifting; but molten metal is distributed by a monorail which extends across the front of the cupolas, down each gangway and into each department. This monorail also is employed to carry cores from the core room to the different molding floors and also at night to carry castings from the gangways where they are shaken out, to the cleaning room. For this latter purpose large wooden boxes with a sling chain from each corner are provided. A number of tractor trucks made by the Buda Engine Co., Harvey, Ill., are used to supplement the work of the cranes and the monorail. The adaptability and flexibility of this type of machine for foundry work is becoming more apparent every day.

Fly wheels, pulleys, etc., produced in the left hand bay, are made on a number of jar-ram, rollover, pattern-draw molding machines made by the Osborn Mfg. Co., Cleveland; the center bay is served by six large and several small machines of the same type made by the Davenport Foundry & Machine Co., Dav-

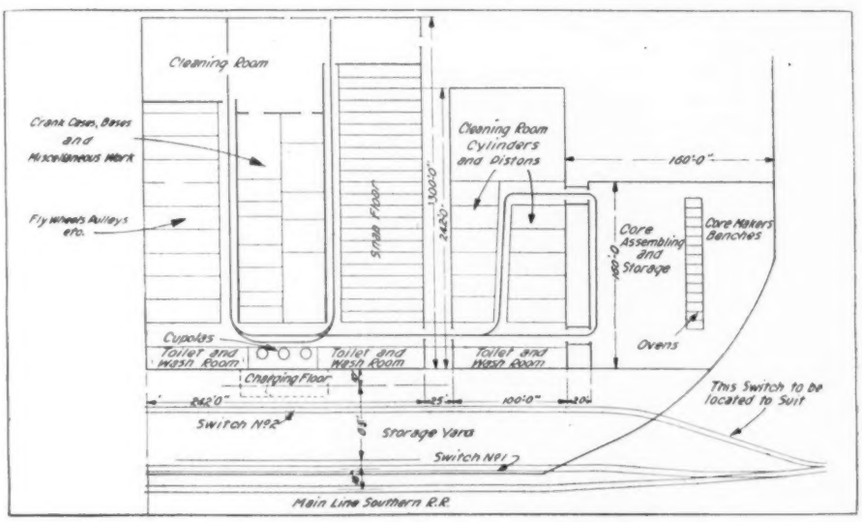



FIG. 3—GENERAL LAYOUT OF THE NEW FOUNDRY OF THE HERCULES GAS ENGINE CO., EVANSVILLE, IND., SHOWING THE THREE DISTINCT UNITS

## FORMULAS FOR THE BRASS FOUNDRYMAN

### Data on Copper, Tin, Phosphorus Alloys

The following data are taken from tables compiled by A. Philip, and included in a paper presented before the Institute of Metals, Great Britain. The formulas have been changed from the original percentages to pounds and ounces, and the phosphorus addition is rendered in terms of phosphor copper, instead of percentage of phosphorus.

#### Bearing Alloy

| | Pounds | Ounces |
|---|---|---|
| Copper | 80 | 4 |
| Fifteen per cent copper | 5 | 4 |
| Tin | 14 | 8 |

The physical properties of this alloy are given as follows:

| | |
|---|---|
| Tensile strength, pounds per square inch | 17,382 |
| Elongation, per cent in 2 inches | 1.0 |

Remarks:—A hard and brittle alloy, likely to break in service unless supported by a backing of tougher metal.

#### Piston Packing Rings

| | Pounds | Ounces |
|---|---|---|
| Copper | 81 | 4 |
| Tin | 10 | 12 |
| Zinc | 3 | 0 |
| Fifteen per cent Phosphor copper | 5 | 0 |

The physical properties of this alloy are:

| | |
|---|---|
| Tensile strength, pounds per square inch | 19,040 |
| Elongation in 2 inches, per cent | 3.0 |

Remarks: The greater ductility that would have been obtained by decreasing the tin, has been largely offset by the addition of zinc. The result, however, is a stronger and more ductile alloy than the first mentioned alloy.

#### Gear Wheels

| | Pounds | Ounces |
|---|---|---|
| Copper | 88 | 1 |
| Tin | 12 | 3 |
| Fifteen per cent Phosphor copper | 9 | 12 |

The physical properties of this alloy are:

| | |
|---|---|
| Tensile strength, pounds per square inch | 30,016 |
| Elongation per cent in 2 inches | 4.5 |

(*Continued on Data Sheet No. 352*)



Note—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note book form.

## FORMULAS FOR THE BRASS FOUNDRYMAN

### Data on Copper, Tin, Phosphorus Alloys

(*Continued from Data Sheet No. 351*)

#### Gear Wheels

| | Pounds | Ounces |
|---|---|---|
| Copper | 87 | 8 |
| Tin | 12 | 0 |
| Fifteen per cent Phosphor copper | 10 | 8 |

The physical properties of this alloy are:

| | |
|---|---|
| Tensile strength, pounds per square inch | 31,123 |
| Elongation, per cent in 2 inches | 7.0 |

#### Piston Packing Rings

| | Pounds | Ounces |
|---|---|---|
| Copper | 82 | 13 |
| Tin | 10 | 11 |
| Fifteen per cent Phosphor copper | 6 | 8 |

The physical properties of this alloy are:

| | |
|---|---|
| Tensile strength, pounds per square inch | 51,968 |
| Elongation, per cent in 2 inches | 6.0 |

#### Bearings

| | Pounds | Ounces |
|---|---|---|
| Copper | 84 | 5 |
| Tin | 10 | 3 |
| Fifteen per cent Phosphor copper | 5 | 8 |

The physical properties of this alloy are:

| | |
|---|---|
| Tensile strength, pounds per square inch | 42,112 |
| Elongation, per cent in 2 inches | 10.0 |

#### Bushings

| | Pounds | Ounces |
|---|---|---|
| Copper | 84 | 7 |
| Tin | 10 | 5 |
| Fifteen per cent Phosphor copper | 5 | 4 |

The physical properties of this alloy are:

| | |
|---|---|
| Tensile strength, pounds per square inch | 42,560 |
| Elongation, per cent in 2 inches | 12.0 |

(*Continued on Data Sheet No. 353*)



THE FOUNDRY DATA SHEET, OCTOBER 1, 1920

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

enport, Iowa; and four plain electric jarram machine made by Henry Pridmore, Chicago. The third or right hand bay is equipped with a battery of squeezers made by the Arcade Mfg. Co., Freeport, Ill. An electric riddle made by the Champion Foundry & Machine Co., Chicago, is used on each floor.

Molding crankcases at the plant of the Hercules Co. does not materially differ from the practice pursued and output secured elsewhere. The average day's work for seven men on one of the Davenport machines is 150 molds. However, at the present time preparations are under way to handle the heaviest crankcase that has yet been attempted by any of the automobile truck or tractor manufacturers. This casting will weigh 480 pounds and an initial order for 20,000 of 80 a day has been promised on this job.

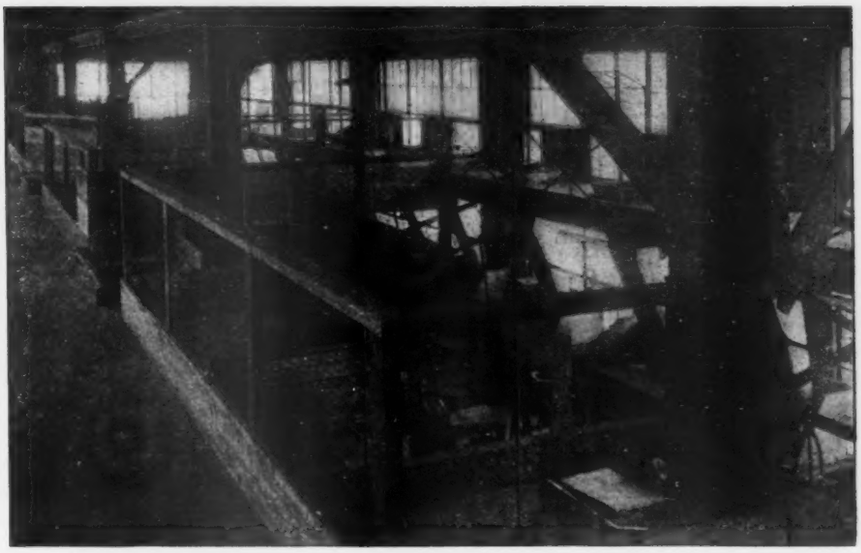


FIG. 5—A BALCONY OVER THE CORE ROOM PERMITS THE SAND TO BE DISTRIBUTED TO THE DIFFERENT BENCHES

### *Melting Equipment Ample*

Only one of the three cupolas which ultimately will be installed is in use. The old foundry still is operating and takes care of practically half of the daily 100-ton heat. The cupola already in use in the new shop and the other two not yet erected were made by the Whiting Foundry Equipment Co., Harvey, Ill. They are uniform in size with 90-inch shells lined down to 72 inches. Each is to be served by an individual blower made by the P. H. & F. M. Roots Co., Connersville, Ind., which will be driven by a 75-horsepower General Electric motor. The new foundry has a melting capacity of 300 tons per day.

The stock yard, 80 x 800 feet, is served by a spur from the main line of the Chicago & Illinois Southern railroad. The coke is unloaded by the machine shown in Fig. 4, but the pig iron up to the present has been unloaded by hand. It is planned to employ a special device in future, built something on the plan of the coke and sand unloader. The pig iron will be carried to the high point of the rollers by magnetic attraction and roll the remainder of the way by gravity. The scrap yard is spanned by two 5-ton Pawling & Harnischfeger cranes. They are used to unload the scrap from the railroad cars by the aid of magnets and also to load the boxes in which the charges for the cupola are made up.

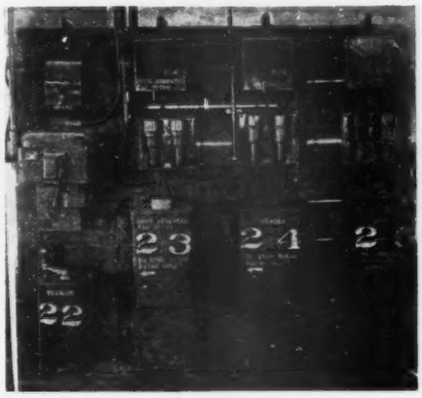



FIG. 6—THE ELECTRICAL CONTROL FOR THE EQUIPMENT IN CLEANING-ROOM IS MOUNTED ON ONE PANEL

The floor of the stock yard is paved with concrete, a feature which facilitates the work of the tractors used in hauling the charges to the cupola elevators. The different grades of pig iron are piled in long bins, each one plainly labeled with the number and class to which it belongs. The space occupied by the pig iron piles is not paved with concrete because it would be smashed up in a short time. Ashes and cinder which form the foundation of the stock yard are left exposed at the points where the pig iron is piled.

### *Making Up the Cupola Charge*

A Fairbanks scale is provided in each of the gangways separating the different piles of pig iron from each other. The trucks on which the charges are made up are spotted on these scales and the necessary amount of pig iron placed on them, after which they are hauled to one of the two elevators which serve the cupola charging platform. The coke and limestone are taken up in a similar manner. The composition of the charges vary to meet the qualifications necessary in the different classes of work handled in the foundry, but they are of uniform weight throughout the duration of the heat. The bed charge of coke consists of 2600 pounds and each succeeding charge is made up of 525 pounds. The iron charges weigh 5000 pounds each. The mezzanine floor housing the blowers 14 feet from the ground and the charging floor 28 feet high are served by two large elevators, one at each end. A considerable part of the daily charge can be

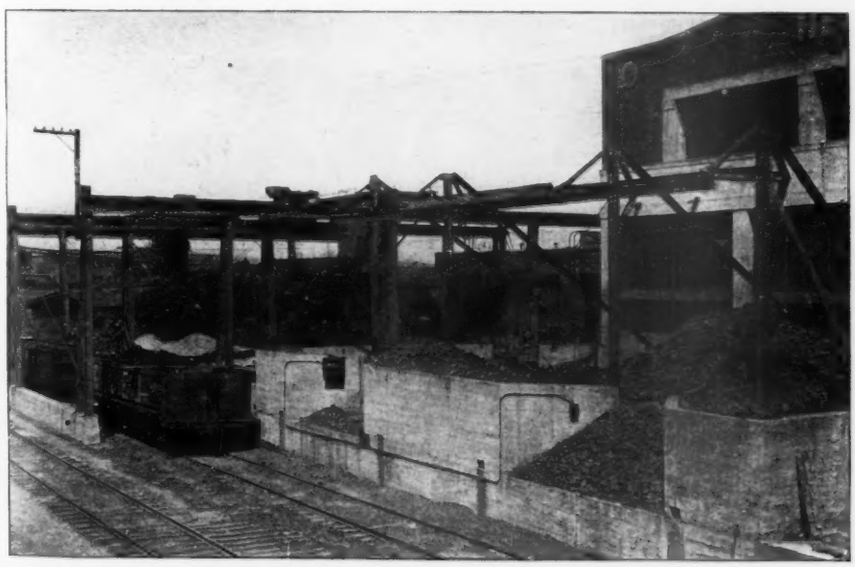


FIG. 4—SCRAP AND COKE STORAGE PILES—THE SCRAP YARD IS SPANNED BY TWO ELECTRIC TRAVELING CRANES AND THE COKE IS UNLOADED BY A MECHANICAL UNLOADING DEVICE

FIG. 7—THE BENCHES ARE USED TO HOLD SAND, RODS, ETC., THE CORES ARE ALL RAMMED ON MACHINES

placed on the charging floor which measures 40 x 76 feet, before melting commences and after that the elevators keep the platform supplied with material as fast as it is charged into the cupolas.

The tumbling barrels in the cleaning room at the opposite end of the building from the cupolas, as well as the dust arresters on the roof, were supplied by the W. W. Sly Mfg. Co., Cleveland. The same company also manufactured the equipment in the cleaning room of the building in which the cylinders, pistons, etc., are made. The main switch and starting boxes for all the motors in one of the cleaning rooms are shown in Fig. 6. Each is numbered and plainly marked. One of these panels attached to the side wall is located in each cleaning room.

### *How the Sand is Mixed*

After the castings are removed at night, the sand on the molding floors is cut over by two sand cutting machines made by the American Foundry Equipment Co., New York. One of these machines also is employed for mixing the green sand facing. In fact, it may be said that the facing sand is put through a double mixing process. The required amount of old and new sand, together with the necessary amount of coal dust, is dumped in a pile close to an 8-foot grinding pan made by the National Engineering Co., Chicago. The sand cutter is driven twice through the sand pile to thoroughly blende the component parts, after which the sand is placed in the grinding pan by a bucket loader which forms an integral part of the mechanism. From the grinding pan it is taken in box trucks and conveyed by tractor to any part of the shop. The one mixer prepares facing sand for both shops.

All of the used and partly burned cores are collected and dumped through a hole in the floor into the basement where they are passed through a sand reclaimer built by the W. W. Sly Mfg. Co., Cleveland. The rods and wires are collected, and straightened when necessary, and the sand is used over again in the core mixtures in varying proportions up to two to one. An oil binder is used for all the cores, which must be strong. The sand for the cores is mixed in the basement and distributed to the coremakers' benches by wheelbarrow. A 6-foot pan made by the National Engineering Co., Chicago, is employed for mixing the sand. A gasoline measuring pump connected by suitable piping to the core oil supply stored under ground outside, is located close to the mixing pan. A card pasted on one of the posts, supporting the platform around the pan has the different core mixtures printed on it, a feature which assists the men engaged at that work. The sand is measured by the wheelbarrow load and when the proper quantity of sand for any particular mixture has been placed in the pan, the pump automatically delivers the right amount of oil directly into the pan.

### *A Well Equipped Core Room*

The core sand is taken from the mixer by wheelbarrow and distributed to the different benches. The barrow is first wheeled onto an elevator, which carries it to the raised balcony shown in Fig. 5. A chute over each coremaker's bench terminates in a hopper in the platform. Some core benches require more sand than others and it is stated that one man with a wheelbarrow can keep an adequate supply of sand in these hoppers with no difficulty.

The core room is laid out in three main divisions The cores are made in the first, they are dried in the second and assembled in the third. A maximum of four days' supply and a mini-

FIG. 8—DISCHARGING SIDE OF THE CORE OVENS—NOTE THE TRANSFER TRUCK ALSO THE GRATING OVER THE FIRING PIT

mum of two days' supply of cores always is maintained in the assembling department.

The cores are rammed on a battery of 29 machines made by the Champion Foundry & Machine Co., Chicago, and on another battery of eight machines made by the International Molding Machine Co., Chicago. The ovens in which the cores are dried are provided with openings and doors at each end. An elevated trackway extends the full length of the battery of ovens at each side. A transfer crane provided with wheels 2 feet in diameter and having a piece of I-beam the width of the gangway suspended from it, operates on this track and is used for handling the racks on which the cores are loaded and dried. An I-beam is suspended from the roof of each oven and extends past the door at each end for a short distance. Corresponding I-beams extending to the core benches on one side and the assembling benches on the other side are provided for conveying the green cores into the ovens in the first instance and out of the ovens in the second. The elevated transfer crane forms the connecting link on each side and provides for lateral transfer.

The core racks are made of perforated steel plate built into a 5-deck structure by an angle iron frame. They never are rested on the floor. Each is suspended by a pair of spiral springs from two small trolleys which run back and forth on the I-beams as shown in Fig. 1. This feature eliminates to a great extent breakage of green cores incident to the shock which sometimes is experienced when a rack is lifted or set down violently.

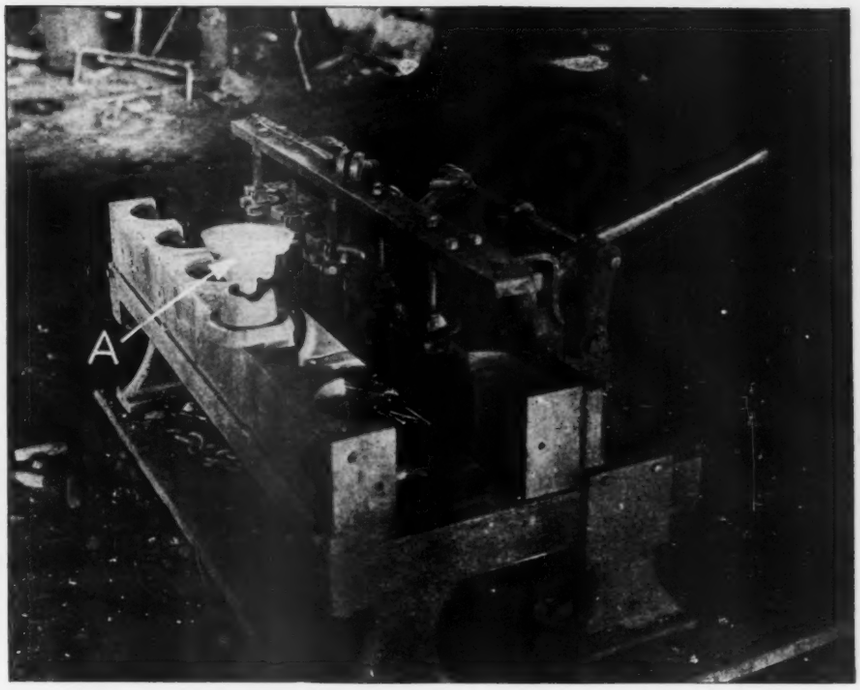



FIG. 10—SPECIAL DEVICE FOR MOLDING SMALL PULLEYS—THE INSIDE OF THE CASTINGS IS FORMED BY DRY-SAND CORES

Half the number of the battery of 14 core ovens to be erected by Clement A. Hardy, Chicago, already is in operation. Individual fireboxes have been provided in the basement for each oven. The heat enters the ovens through holes in the floor and the steam escapes through openings in the walls connecting with a common flue leading to a stack at the end of the battery. This flue is 4 feet high and provides ample room for a man to go inside to clean it occasionally. The openings in the floor and also in the walls of the ovens are provided with suitable damper plates by which the heat of the oven may be regulated. Indicating pyrometers made by the Brown Instrument Co., Philadelphia, which at first were attached to the walls of the ovens since have been moved to the basement where the fireman can observe them and govern himself accordingly. Each oven is 6 x 8 x 19 feet.

For transferring small cores from the assembling room to the foundry, wooden boxes suitably marked to indicate the nature of the contents are employed. The larger cores are loaded on racks similar to those on which they are dried with the exception that they are provided with wheels under each corner and may be pushed from place to place. These racks also may be picked up by the lift trucks and set down wherever necessary.

FIG. 9—A FLOOR OF PISTONS, EIGHT IN A FLASK—THE CORE FRAME IS PROVIDED WITH WHEELS FOR CONVEYING THE CORES FROM THE STOCK ROOM TO THE MOLDING FLOOR

### *Pistons Method Novel*

The building in the center of the illustration, Fig. 3, is fitted up specially for making cylinders and pistons on one side of the central gangway and small miscellaneous snap work on the other. The cylinder space is laid out into six floors each spanned by two hand-operated air cranes. The bridge of each of these cranes consists of a single I-beam attached to a light truck at each end, mounted on a pair of large wheels. A 1-ton pneumatic crane made by the Curtis Pneumatic Ma-

FIG. 11—A FLOOR OF FLY WHEEL MOLDS—THE FLASKS ARE RAMMED ON THE MACHINE IN THE LEFT FOREGROUND

chinery Co., St. Louis, Mo., is suspended from each crane bridge.

The pistons shown in the illustration, Fig. 9, are made on a jar-ram, roll-over, pattern-draw machine made by the Davenport Foundry & Machine Co., Davenport, Iowa. As may be seen in the illustration, no cope is required. Eight patterns provided with square prints are rammed in green sand in an iron drag. After the flask has been rolled over and the patterns drawn, the drag is set on the floor and the cores which act as a cope or cover core are lowered into place. A gate extending around each piston and connecting with a common runner in the center of each group of four also is provided in the core. After the cores are set, an iron frame with two openings corresponding to the runners in the cores is set on and clamped. It is not necessary to build up a sand basin in which to pour the metal.

A typical example of the many ingeniuos and economical shop kinks practiced at this plant, is the device shown in Fig. 10, used for making small pulleys. It consists of a heavy permanent base mounted on four legs and planed perfectly true on the upper side. Two heavy castings, also machined accurately to form the outside of six pulley molds, are mounted on the base. One half mold is attached firmly to the base plate, while the other can be moved back and forth in a straight line by a suitable lever and toggle arrangement. The inside, top and bottom edges of the pulleys are made with cores. The mold is thrown open as it is shown in the illustration and all loose sand blown out with an air hose. The top, bottom and center cores are assembled as shown at *A*, Fig. 10, and slid into place, after which the movable half of the mold is pushed forward. The screw bolts hanging from the bar are used to hold down the cores while the casting is being poured. A flat depression on the side of each core print insures that the top and bottom halves of the core will be assembled in the proper relative position to each other. Each of the pulleys is poured through a small hole in the top core. The machine is operated by a laborer who experiences no trouble in pouring an average of 300 pulleys during the afternoon heat.

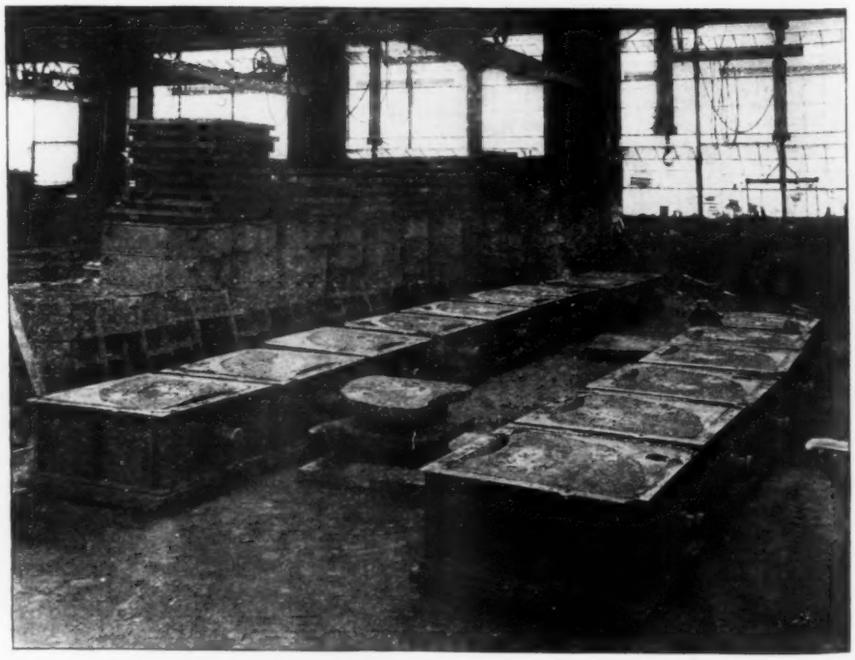


FIG. 12—A FLOOR OF BUSHING PRESS BASES MADE ON ONE OF THE CYLINDER FLOORS—THE CORE ALSO SERVES AS A COPE

# Points on Grinding Iron Castings

## Selection of the Proper Equipment and Efficient Handling of Rough and Cleaned Castings Effect Savings—An Adequate Record System Is Important in Securing Efficiency

BY L. M. KRULL

OVERHEAD and labor are the two most important cost items in a cast iron cleaning room because carbide of silicon wheels which are used for snagging the castings have a comparatively long life. For this reason, the wheel cost per unit of product is small compared with the labor and overhead for the same unit.

The amount of grinding to be done on a casting is in proportion to the excess metal left after the gates and fins have been knocked off. Bad practice in gating castings results in excessive grinding. Often it is necessary to use a hammer at the grinding wheel to knock off these projections. This requires time. Where it is possible and feasible, the gates should be molded instead of hand cut, and they should be so tapered that they may be broken near the casting. Broad thin gates break better than thicker and narrower ones.

The method of handling castings during the cleaning operations has a marked influence on economy. The main purpose is to keep the wheels of the grinding machines in contact with the castings for as much of the day's time as is possible. The time spent in getting a casting to the grinding wheel and properly disposing of it after grinding should be kept at a minimum. This can be brought about by proper arrangement of machines and a good system of trucking. The castings should be sorted into three groups, heavy, medium and light. Large heavy castings are ground by means of swing frame machines, or portable grinding machines. These machines should be placed in easy reach of the crane. All castings that can be handled readily, that is, from 1½ to 60 pounds should be snagged on floor stands, while castings smaller than 1½ pounds are more economically ground on bench stands.

Feeding the castings to the grinding machines and removing the finished pieces without interruption and interference so that continuous work is possible are prime considerations. Rough

The author, L. M. Krull, is an engineer for the Norton Co., Worcester, Mass.

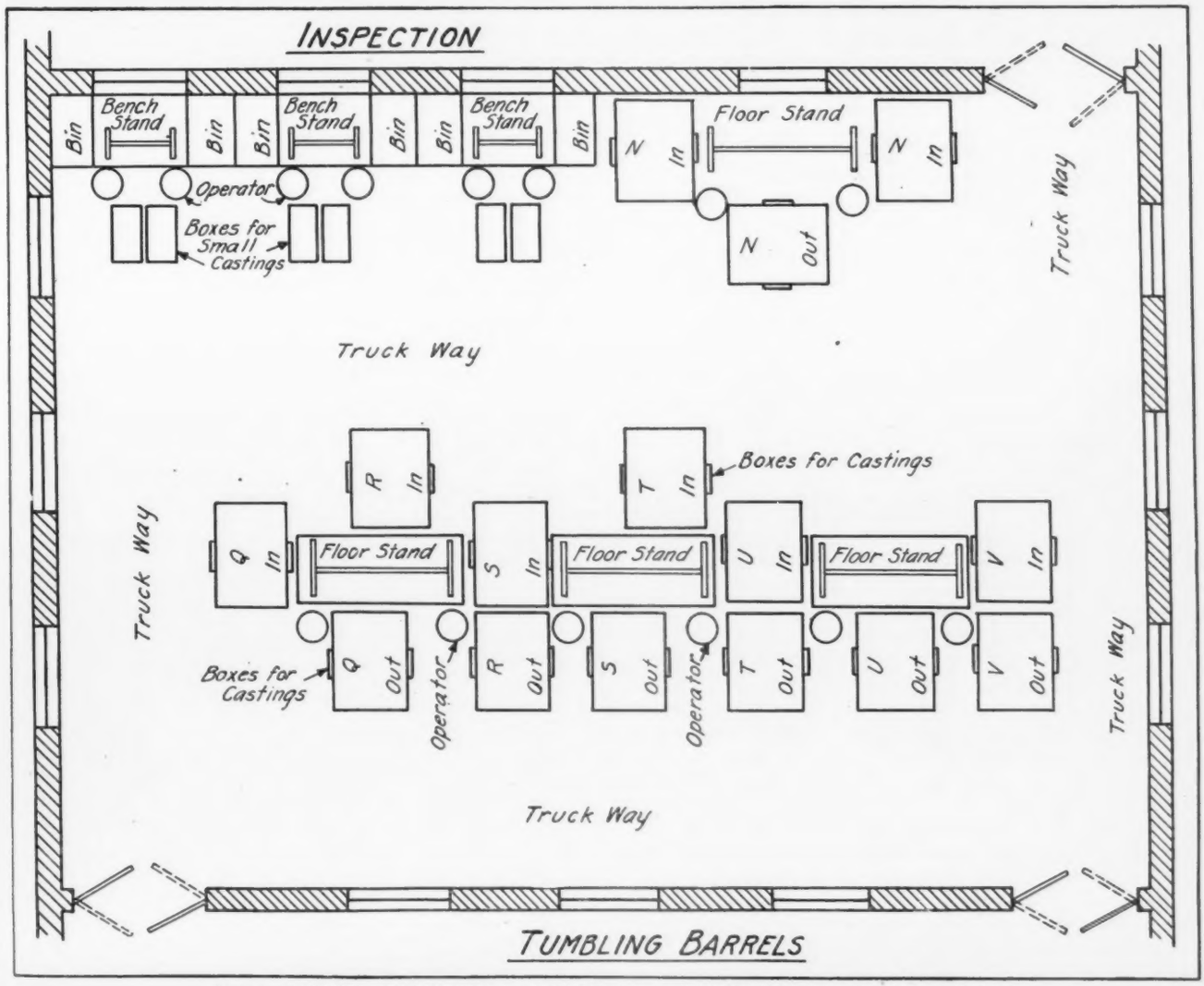



FIG. 1—SUGGESTED ARRANGEMENT OF GRINDERS IN A CLEANING ROOM OF A GRAY-IRON FOUNDRY

light castings must be placed within easy reach so that the operator can grasp them with one hand and deposit them into another container with the other hand, without turning away from his machine.

Bench stands may be arranged along a wall upon solid benches. A suggested arrangement is shown in the accompanying Fig. 1. The small castings are easily shoveled into the bins at the side of each wheel. The grinder then is in position to handle them most rapidly, depositing the finished pieces in small kegs or boxes which stand on the floor beside him. These later may be removed by truckmen.

Floor stands are best arranged in a line at a sufficient distance from any wall or other machines so that the boxes of castings may be fed to them from one side and taken away at the other with ample room for the truck.

A good box for the floor stand castings is one which measures about 3 x 4 feet. This should be mounted upon two 12-inch wheels at the center and 3-inch casters on each corner, which will clear the floor by ½-inch when the box is level. Such a box may be shifted about by the operators and also may be lifted by an electric lift truck, or pulled about by a tractor.

*Conserving Grinding Equipment*

Grinding costs are seldom placed under observation and therefore little thought is given to grinding equipment. The greatest success of any machine is in its running free of vibration. Vibration hastens depreciation and increases cost of repairs. In a grinding stand it annoys the operator, makes him dissatisfied and tires him. It wears away the grinding wheel because of the continual hammering and tends to make it constantly out of round. The operator then trues the wheel to remedy this condition and again wastes wheel material. Further, with excessive vibration, depreciation and repair items become alarmingly great. Many cases of increased wheel wear may be traced to vibration alone. In one foundry where the machine equipment was light, poorly mounted and in bad condition as regards bearings, the wheel wear was 1.13 cubic inches per hour. In another where the wheels were mounted on medium heavy machines and rather well kept, but using the same wheel as to size, grain and grade, the abrasive consumption was only 0.58 cubic inches per hour or about half the amount. The castings ground were identical in both instances.

Vibration may be reduced by the use of heavy machines bolted securely to a concrete floor. This is necessary to absorb the slightly out of balance condition that any grinding wheel may inherently have or acquire when worn slightly out of round.

*Choosing the Wheel*

Cast iron is comparatively low in tensile strength. Because of this, carbide of silicon should be employed as the abrasive. This is a tremendously hard substance and just brittle enough to shatter when necessary. This, in connection with the correct grain size and bond strength of wheel produces an efficient tool. The great question generally is what grain and grade (bond strength) must be used for snagging cast iron castings. Different conditions so influence the selection that a test is often advisable. The wheel should be of such a bond strength that grains shall tear out of their setting when dulled, and of such a grain size that penetration shall be a maximum unless the finish required enters into the operation. Such a wheel would require little dressing for sharpening the wheel face.

The great factors that affect wheel selection are:

Type and condition of machine.
Material, size and shape of castings.
Speed of wheel.
Personal factor due to operator.

The effect of good machine equipment on wheel wear was cited previously. To remedy the abnormally excessive wheel consumption under high vibration much harder wheels were installed in the first case. This had the desired effect in prolonging the life as well as better preserving the shape of the face but it sacrificed the cutting. However, it proved more efficient to use the harder wheel in spite of the slight decrease in cutting in that particular case.

Large castings generally require a coarser, harder wheel than small castings. This is because the pressure exerted by the operator is usually greater. Also the inertia or that property which governs the rebound of the casting from the wheel is greater. In general, the greater the mass of the casting, in comparison to the mass of wheel, the harder must be the wheel, other things being equal. Coarse grinding wheels remove metal most rapidly when the castings are soft. This is readily understood when grain penetration is remembered. On the other hand, for harder castings or castings having a hard skin, slightly finer grained wheels are best. Shape also should be considered. Stove plates for example, where the grinding

**INDIVIDUAL RECORD SHEET**

Workman No.

| | | A | | | B | C | D | | E | F | G | H | I |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Wheel Make and Specification | Machine Number | Class of Castings | Date and Diameter on | Date and Diameter off | Total Working hrs. in use | Volume of Wheel used (cu. in.) | Total Tons of Castings Ground | Total Earnings of Operator | Cost of Wheel Material Consumed | Wheel Cost per ton of Castings | Overhead cost per ton of Castings | Labor Cost per ton of Castings Ground | Total Grinding Cost per ton |
| Norton 20X2-24R | 18 | C | July 18 20" | Sept. 3 16" | 375 | 226 | 300 | $261.00 | $9.04 | $0.030 | $1.250 | $0.90 | $2.180 |
| Norton 20X2-20S | 18 | C | Sept. 3 20" | Oct. 28 16" | 450 | 226 | 335 | $301.00 | $9.04 | $0.027 | $1.345 | $0.90 | $2.272 |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |

FIG. 2—RECORD SHEET FOR MAINTAINING CHECK UPON EFFICIENCY OF MEN AND MACHINES IN THE GRINDING ROOM

A=Class of castings which are from 7 to 60 lbs. B=Cubic inches of wheel structure consumed=$2\pi\ (R^2-r^2)=2 \times 3.1416\ (100-64)$. R=radius of 20" wheel, r of 16". E=If wheel is finally discarded at 9" diameter, the available abrasive material costs 4 cents per cu. inch. This can be figured by looking up list price of crystolon wheel minus 50% discount and dividing by the number of cubic inches the wheel has outside of the 9" center which is discarded. F=E÷D. G=B multiplied by the overhead per hour (which in this case equals $1.00) divided by D. H=Labor cost per ton—piece rate or figured from hourly rate. This case is piece rate. I=F + G + H.

is always the removal of sharp fins and flashes and where the wheel edge is constantly used for cleaning corners, a finer harder wheel must be used, because of the dressing action and the small contact of work on wheel.

By personal factor is meant the aggressiveness of the workman. When on piece work it is noticeable that the men *punish* the wheel more than when on day rate. Under such conditions of increased pressure and roughness, a harder wheel must be employed.

The wheel should never run much less than 5000 surface feet per minute for efficiency nor more than 6000 for safety's sake. The importance of maintaining this speed between these two limits cannot be expressed too strongly. As the wheel speed decreases, the rate of cutting decreases proportionally if the pressure is maintained equal and the wheel wear in cubic inches per unit of product increases. The first is quite obvious if we consider each grain in the light of a tooth on a cutter. The second is true because the wheel surrenders particles much more readily as its peripheral speed is decreased.

In practice, when a piece rate is used, an operator must exert more pressure upon the wheel so that a greater chip is cut by each grain, to compensate for the loss in speed. This causes excessive wheel wear. The total life of a snagging wheel is from 20 to 30 per cent less than one might suppose when calculated from the life of the first half inch of diameter consumed, when wheels 16 inches and more in diameter are used.

Because of the vital importance in maintaining the proper wheel speeds many foundries have adopted proper methods to effect this when their stands are not self contained and equipped with variable speed motors and are not belted to jack shafts with cone pulleys. Change in speed is effected by using the same wheel successively on two or three different machines, each having successively a higher speed. For example, a 20-inch wheel is worn down to 16-inch diameter on one machine having a speed of about 1125 revolutions per minute. It is then taken off and mounted on a second machine rotating at about 1450 revolutions per minute, and lastly at 12 inches it is put on a bench stand the spindle of whcih revolves at about 1900 revolutions per minute.

There should be a wheel operating in a convenient place for the chippers to sharpen their chisels and on which molders can keep their shovels straight and sharp. Such a wheel must be finer and softer than the snagging wheel in the cleaning room so as not to draw the temper from the tools.

In many cleaning rooms the operators still are paid by the hour. This is buying time rather than work done. Whenever a piece rate system can be installed, the step should be taken. Even if production increase alone is the result and the piece rate was such as it would be as figured from old performances at day rate, there would be a large decrease in overhead. Thus at $1 an hour, per man, overhead, an increase in production of 50 per cent means a reduction of 33 per cent in the overhead charge per unit of product or approximately $3 per day per man for a 9-hour day. For example, if 1000 pounds of a certain size of casting could be snagged in one hour and an increase in production of 50 per cent was effected, the operator would then grind 1500 pounds in the same time. The overhead charge at 100 per hour would be $1 per 1000 pounds before the 50 per cent production increase and $0.66 per 1000 pounds after the increase, or a 33 per cent decrease per 1000 pounds of castings ground. The success of this system lies in the setting the rates based on scientific principles.

Large industrial foundries have no trouble in this respect because here there is a constant duplication of parts for which an accurate rate can be set either per 100 pieces or per ton. A jobbing foundry finds it more difficult, but even here it might be accomplished. By dividing the castings that can be ground on floor or bench stands in three groups, *A*, *B* and *C*, the rate per ton for each can be quite satisfactorily determined. Such a classification would be approximately such that group *A* castings contained those weighing approximately 1½ pounds and less, group *B* from 1½ to 7 pounds and group *C* from 7 to 60 pounds. All group *A* castings would be ground on bench stands while *B* and *C* would be ground on the floor stands. For class *A* perhaps from 200 to 500 pounds could be snagged per hour or an average of 350 pounds per hour per man. Perhaps 800 pounds per hour could be done for the intermediate and 1500 pounds per hour per man for the class *C* castings. If it was found that these figures held such an average over a period of a month, the basic rate could then be determined.

A record kept by the foreman as to the performance of wheels and operators enables one to detect instantly the good and poor workman, and the average life and productiveness of wheels in comparison to new trial wheels that are being tested. The actual cost of grinding which is the sum of three factors, namely, wheel cost, overhead and labor, enables the foreman to direct his energies toward their reduction. A record of this kind also enables one to determine the feasibility of instituting the piece rate system and a fair idea of the rates that might be set. Fig. 2 is a recommended form of record sheet for each workman. The most efficient wheel to use will show itself quickly in the final column, namely, the total grinding cost.

## Wisconsin Iron Foundry Started

One of the largest gray iron foundries in Wisconsin, outside of Milwaukee, has been erected and equipped at Sheboygan by the Globe Metal Products Corp., a $200,000 corporation formed by interests identified with the former Globe Foundry & Machine Co., which is now the Globe Co. The new company will furnish castings to the Globe Co. as well as the Honold Mfg. Co., but will be essentially a commercial jobbing shop.

## Organizes New Castings Company

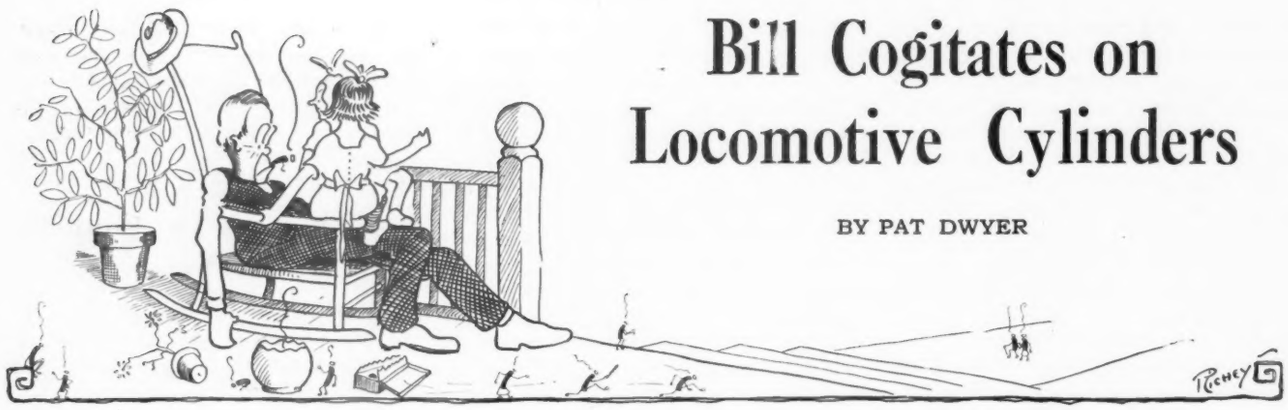
William J. Muhlitner, who was actively identified with the Detroit Foundry Co., for six years, and since 1915 has been secretary and manager of the Foundry & Machine Products Co. Detroit, has organized the Automotive Castings Co., and has purchased the plant and business of the Merrill Mfg. Co. Inc., Imlay City, Mich. The new corporation is now operating daily in the manufacture of gray iron castings.

## Resistance Alloy Patented

An alloy containing copper, nickel, iron, zinc and a purifying agent has been made the subject of a patent No. 1350166 in the United States patent office by Foster Milliken, Lawrence, N. Y., and assigned to Foster Milliken, S. Fullerton Weaver and James M. Repplier, trustees. It is claimed that the alloy is characterized by increased electrical resistance, increased elastic limit, increased tensile strength, increased density, a close and fine grain and a high resistance to corrosion.

## Metallurgist Honored

M. Charles Laurent, president of the French Union of Métallurgical and Mining Industries, has been appointed French ambassador in Berlin. He represented the Association of Electrical Plant manufacturers in the Union, and his place in the presidential chair has been taken by M. Gabriel Cordier, president of the Association of Hydraulical Engineers.



# Bill Cogitates on Locomotive Cylinders

BY PAT DWYER

ONE night recently I was seated on the front porch enjoying a draft of the weed that made Sir Walter Raleigh famous. Coincident with this form of exercise, I also was engaged in that gentle form of recreation known among truly refined people as "taking the air." Fortunately, up to the present time there is no restriction on the quantity of this commodity which any one person may consume and therefore I was inhaling it freely with nothing to mar my enjoyment. Two charming young ladies were seated, one on each arm of my chair and with their feet sprawled in a every unladylike attitude in my lap. They were insisting that I tell them a story, but as each one had decided opinions on the particular story I should tell them I naturally felt embarrassed since I am devoted to each of them equally. I was saved from making a choice by the appearance of Bill, who said he had come over to borrow a book I had promised him describing the manufacture of mission furniture. One of the young ladies was dispatched to find the book and in the meantime Bill filled an old corn cob pipe which accompanies him everywhere he goes and sat down alongside me.

BILL'S APPEARANCE SAVED ONE REPUTATION FOR PROFOUND KNOWLEDGE

Just then one of those big compound locomotives pulling a freight train about a mile long, passed on a track situated a few hundred yards from where we live. There is a stiff grade at this point and the old locomotive was coughing and shooting up clouds of sparks. I said to Bill that the present day locomotives were powerful brutes and represented a vast advancement in the solving of transportation problems since Stephenson built the Rocket. Bill said that was so and having settled himself comfortably continued:

"I worked at one time in the foundry of a plant where locomotives were built. The shop was presided over by a civil war veteran who sported a set of Lord Dundreary whiskers. In spite of this handicap he could chew more tobacco and expectorate further than any man I ever saw, either before or since, and mind you I have seen some experts. He always carried an immaculate white linen handkerchief and used it to brush off his flowing facial fringes at frequent intervals. How he kept it white was a source of perpetual wonder to me. In common with other gentlemen who toiled with their feet and hands in the foundry in those days, I carried no handkerchief at all and this display and ostentation on the part of the superintendent was regarded by the rank and file (rank is right) as an outward, tangible evidence of the importance of his position.

"The feeling corresponded in a mild way with that felt for sovereignty by natives of those countries presided over by a monarchial form of government. The saints be between us and all harm, but I was young in those days and had a wonderful respect for lawful authority and was duly impressed by the outward signs of greatness adopted by those who sometimes sat in high places. I got over that nicely in after years, partly through a species of evolution that enables us to see things more clearly as we grow older and partly from the fact that I have sat on one or two of those high seats and have found out that foundry superintendents have as many troubles as molders and then some for good measure."

"Never mind the sermon," I said, "I never knew a man yet who did not think his particular job the hardest, most difficult and thankless job in all this wide world. As for your vaunted independence and utter disregard for lawful authority, why I know for a fact that one look from Mrs. Bill has more effect on you, than the most stentorian 'Shun' from a top sergeant has on a rookie. What about this locomotive place you started talking about?"

"Do you know," said Bill, "I'd hate to work for you. You are like one of those birds who come along after a man has a job half rammed up and asks him if he is sure he placed a bearing under the core prints; or if he pulled the nails out of the lose pieces on the sides. The man making the job knows as much about it and probably little more than the man with a one dollar mind trying to swing a two dollar job and having attended to all these routine details as he went along naturally feels irritated when this superior lump of wisdom comes along handing out patronizing and gratuitous advice. I might enlarge on this subject indefinitely but it probably would go over your head so what's the use? Your comparison of Mrs. Bill to a top sergeant also shows a deplorable lack of knowledge of human nature. 'Tis true Mrs. Bill has a way with her; most ladies have; but you have another guess coming if you think that fear is the motive which makes me jump when she bends on me one of those glances from her bonny blue eye."

"Wait just a minute," I said. "Wait a minute; if you are going to talk about ladies, go ahead and talk about 'em. 'Tis an easy subject to listen to; but if you are going to talk about locomotives I wish you would leave the ladies out of it. A locomotive is no place for a lady anyway." "All right," said he, "We'll make this a strictly stag affair. As I was saying when you interrupted me so rudely, I was a young knight errant in those days, seeking adventure and advancement rather than filthy lucre. Having heard of this famous locomotive shop from various knights of the road I decided there was much merit to be gained from an encounter so I journeyed down that way and made a strategic entrance through the chipping room door during the temporary absence of the watchman from his post of duty.

A SOFT ANSWER TURNETH AWAY MANY A HARSH OFFICER

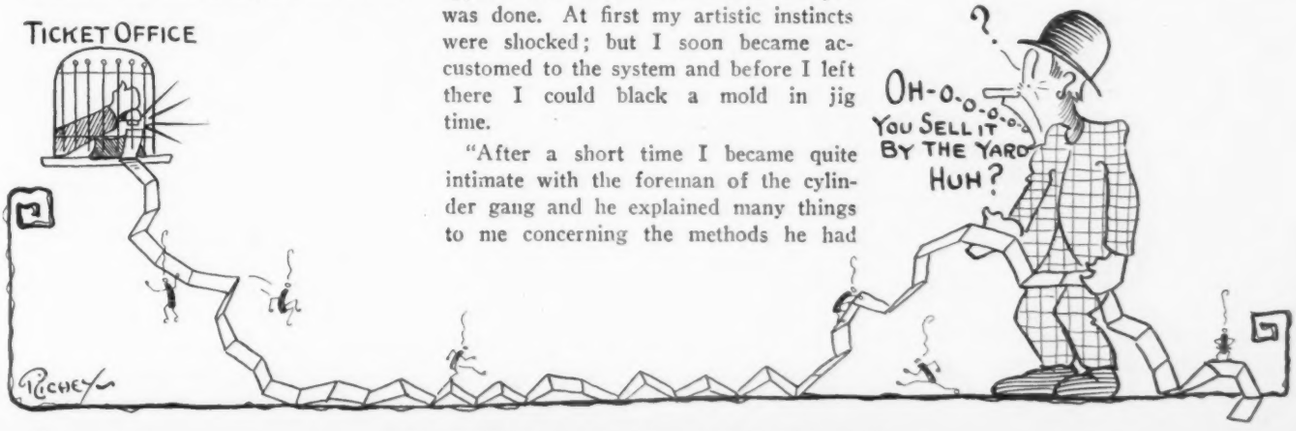
"I gave the place the up-and-down and the once-over and had decided to tender my sword and my services for a limited engagement, when one of the watchmen saw me and indignantly ordered me out. Did I assume a guilty look and beat it for the door? I'll say I did not. I patted him on the shoulder and commended him warmly for his devotion to duty. I assured him that I would speak of it to my father who was one of the directors of the company. I said that we were making a tour of inspection and I had become temporarily separated from the remainder of the party and if he would kindly direct me to the office of the superintendent I would remain forever in his debt. He not only directed me but he insisted on accompanying me to the door of the office and bade me goodbye in the most respectful manner. I worked there for eight months after that and do you know until the day I left you could not make that man believe that I was not working incognito. As that sterling old patriot and philosopher Benjamin Franklin said in his column one day: 'An ounce of bluff is better than a pound of if-you-please-sir.'

"I had made cylinders for steam engines, both marine and stationary in several shops before I landed in this locomotive place and had all the necessary tools for making an artistic job of slicking the blacking before applying the last coat of molasses water with a fine camels hair brush. I found no use for them in this shop; not even for a swab. The men splashed the wet blacking on the face of the mold with long, flat bristle brushes; threw some dry blacking over it; then slicked the plain flat and round surfaces with a finishing trowel; went over the edges and corners with a thin coat of blacking applied with a fine brush and the job was done. At first my artistic instincts were shocked; but I soon became accustomed to the system and before I left there I could black a mold in jig time.

"After a short time I became quite intimate with the foreman of the cylinder gang and he explained many things to me concerning the methods he had devised for securing production. In the early days when 3 or 4 cylinders a day met all requirements each molder made his own mold; finished it in orthodox style, cored it, closed it, made up his runner and poured it. When the business grew to such an extent that the foundry was called upon to deliver 12, 14, 16 and finally 20 cylinders a day, considerable difficulty was experienced in securing a sufficient number of skilled molders. It then was decided to take on all kinds of molders and sub-divide the work The more highly skilled men were delegated to finish the molds, black them and set the cores. The others, who were mostly floaters, here today and gone tomorrow, were kept ramming the molds.

"The rammers were paid a straight day wage; but the finishers, in addition to a wage rate higher than the others were paid a bonus on the total tonnage of good castings produced each month. The naural result was that the latter speeded up the work all they could and kept the former hopping. In addition to the pressure brought to bear upon them by their colleagues the straight day men had the incentive of knowing that if they showed sufficient ability they would be advanced into the preferred class and have a chance to share in the increased emolument.

"On coming to work in the morning we would find the rollover boards all down, the patterns set and the drags in place. Two molders would go to each flask, with a helper if there was one, and without if none was available. A long upright runner about 2 inches square was located about 4 inches from




BILL TRAVELED SOME BEFORE THE RATES WERE RAISED

the straight flange by which the pair of cylinders are bolted together when the locomotive is assembled. Two cast-iron draw gates approximately 4 x 3-4 inches were attached to the pattern connecting the runner to the flange; one near the bottom and the other near the top. Facing sand was shoveled in around the pattern to a depth of about 6 inches, followed by a heap of sand to the same depth. Each course of sand received just one peining about an inch back from the pattern. The remainder of the course was tramped off and butted. That was one valuable thing I learned there. You know it is a pitiful sight to see a man slowly and painstakingly using a pein rammer over a wide area of sand in a mold, particularly a dry sand mold, when all it needs, after tucking around the pattern, is a good application of the butt.

"The saddle flanges on the pattern were loose and were drawn out after the sand has been rammed flush with the top edges. The mold impression left by the flanges then was nailed along the edge and blacked after which suitable covering cores were placed over the openings. The remainder of the drag was filled and rammed. Long slender sticks were set on the exhaust, lightening and port core prints. These were intended to furnish a clear vent for the cores. A riddle full of coke was distributed over the first ramming of sand under the curved part of the pattern. It was carried all the way across the drag and communicated on each side with openings in the sides of the flask. After the bottom plate was tried on and rapped down it was lifted again and a number of channels scraped in the sand to facilitate the escape of the steam and gas. The bottom plate was then replaced, bolted to the flange of the drag on two opposite sides and clamped on the remaining sides.

"Ramming the cope also was simplified. The bars over the flat part were few and far between and it was necessary to depend on hook gaggers to get a lift. There were no bars in that part of the cope which covered the barrel. After the sand was rammed, a flat plate provided with two holes, one over each flange for the riser, was clamped on over the barrel. Openings were provided in the sides of the flask at the barrel ends and a sharp dog at each side served to bring the half barrel pattern up with the cope. The pattern supported the sand until the cope was turned over and after the cope was dried it was quite safe to turn it back again.

"After the mold was finished and blacked all the cores were set with the exception of the main barrel core. That core was set on the following day after the mold came out of the oven.

"To minimize the risk of crushing molds on account of this gang production, it was customary to shave all the joints liberally. To prevent runouts it was the duty of one old veteran to go around the joints of all the flasks after they were closed and pack them with small rods and daub them with clay. The gang foreman poured the ladles personally."

"I learned many valuable lessons there," said Bill as he stood up and prepared to go, "lessons that were of great assistance to me later but the monotony was too much for me after a time, so I polished up the kit of tools which were pretty rusty by that time, bought a ticket about as long as a hand rammer and on a following day got a job in a roll shop in another town, but as our mutual friend R. Kipling used to say 'that is another story'."

"Well," I said, "if you insist on going don't let me detain you but I should like to see what kind of emotion you register when Mrs. Bill tells you it's a wonder you didn't stay out all night."

"You tell 'em Babe," said Bill with a grin, "you can make a hit."

## Steel Treaters Meet in Philadelphia

Optimism for the future of the American Society for Steel Treating, an amalgamation of the American Steel Treaters' society and the Steel Treating Research society, was expressed by officers and members of the new society which held its annual meeting and exhibition in the Philadelphia Commercial Museum, Philadelphia, Sept. 14-18. Consolidation of the two pioneer societies was effected at the opening session, the program of which consisted of addresses of welcome and presentations of reports of the presidents of the two organizations and the chairman of the amalgamation committee.

Both societies in their short existence have had rapid and healthy growths, particularly during the war period when because of the demand for steel material, heat treatment was of vital importance. Through the combined strength in numbers and the increased resources, the new society is enabled to undertake larger tasks in the field of steel treatment and great benefit is expected from the consolidation.

Attendance at the meetings increased daily throughout the convention until the total reached over 1500 members, guests and exhibitors. Of the eight scheduled sessions, seven were devoted entirely to the presentation and discussion of technical papers, of which 28 were presented in full and an equal number by title. Among the papers presented were: "Oxidation of Steel During the Period of Heating" by H. O. Loebell, Henry L. Doherty & Co., New York; "A Suggested Method for Determining the Comparative Efficiency of Certain Combinations of Alloys in Steel" by J. D. Cutter, metallurgist, Climax Molybdenum Co., New York; "Relative Thermal Economy of Electric and Fuel Fired Furnaces" by E. F. Collins, consulting engineer, industrial heating devices, General Electric Co., Schenectady, N. Y.; "The Relation of Chemistry to the Fabrication of Steels" by Dr. J. Culver Hartzell, Dalton Adding Machine Co., Cincinnati; and "The Department of Metallurgy of the Bureau of Standards" illustrated by moving pictures by H. J. French, Bureau of Standards, Washington.

Much interest was attracted to the exhibition at which over 100 manufacturers were represented with displays of machinery, equipment and products. Of this number many were showing their equipment in operation. Attention was divided between oil-fired furnaces, testing machines and recording instruments. The exhibition was open during the convention meetings and also on Saturday following.

With an informal banquet on Thursday evening at the Bellevue-Stratford hotel, the scheduled program of the convention was concluded. More than 700 member and guests attended this entertainment at which Joseph A. Steinmetz, Janney & Steinmetz, Philadelphia, and past president Philadelphia Engineers club was the toastmaster and Dr. Albert Sauveur, professor of metallurgy, Harvard university, Cambridge, Mass.; Dr. Joseph W. Richards, professor in charge department of metallurgy, Lehigh university, South Bethlehem, Pa.; and Samuel Vauclain, president Baldwin Locomotive works, Philadelphia were the speakers. Friday morning was devoted to inspection trips to Philadelphia industrial plants including Leeds & Northrup Co., Edward G. Budd Mfg. Co., and Hess-Bright Mfg. Co., and Friday afternoon to visits to League Island navy yard, Hog Island and Midvale Steel & Ordnance Co.

New officers for the society are: President, one year, Lieut. Col. Albert E. White, professor of chemical engineering, University of Michigan, Ann Arbor, Mich.; first vice president, two years, Theodore E. Barker, production engineer, Miehle Printing Press & Mfg. Co., Chicago; second vice president, one year, T. D. Lynch, research engineer, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.; secretary, two years,

William H. Eisenman, 208 N. Wabash avenue, Chicago; treasurer, one year, William S. Bidle, president W. S. Bidle Co., Cleveland; directors, two years, Howard J. Stagg, assistant manager Halcomb Steel Co., Syracuse, N. Y., and Emil J. Janitzky, metallurgical engineer, Illinois Steel Co., South Chicago, Ill.; directors, one year, Walter C. Peterson, metallurgist Packard Motor Car Co., Detroit and Frank Fahy, consulting engineer, New York.

# Pointers for Pattern Shop Apprentices

BY M. E. DUGGAN

A TOOL which has been designed by an artist, finished by an expert and given a sweet cutting edge by an experienced patternmaker, is pleasing to the eye and a delight to the hand and mind of the man who uses it. A chisel, a gouge, a plane knife or any edge tool that will not take on a keen edge should be thrown away or should be kept in a convenient place for the benefit of the chronic borrower.

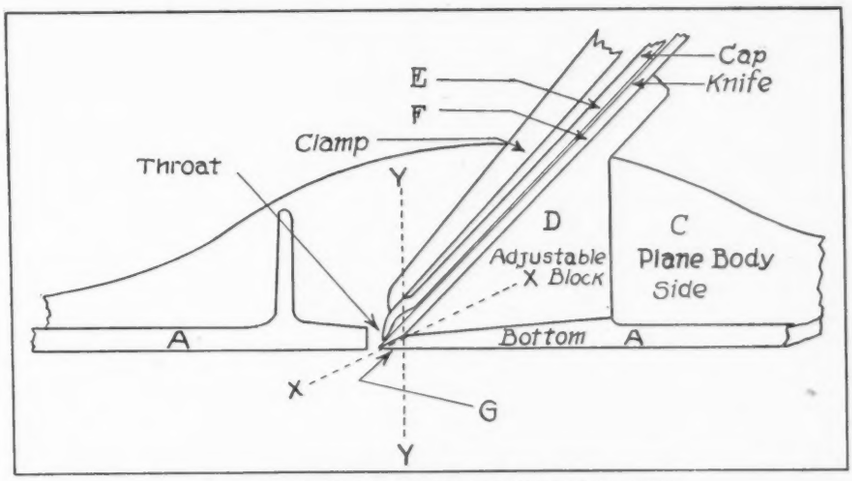



FIG. 1—COMPONENT PARTS OF ORDINARY HAND PLANE

In a certain shop where I was employed one of the apprentices had a mania for buying new tools. While they were new and sharp he used them to the best of his ability, but when they became dull he laid them aside and borrowed tools from the other workmen. One day a new patternmaker started to work in the shop. He had a fine set of flat chisels with bent shanks. When the apprentice saw them he thought he understood why it was that he could not do a good job with his straight shank chisels. He knew absolutely nothing of how tools are made, neither did he ask for any information but started in to bend the shanks of his new chisels. He succeeded in spoiling half the set before the foreman discovered what he was doing, and stopped him.

Another apprentice spoiled a new plane by filing away the throat shown at *G*, Fig. 1, where it supports the cutting edge of the knife. When asked to give a reason for his action he blamed everything but his own lack of judgment. He said that the slot in the bottom of the plane was too wide and in order to correct it he had moved the adjustable block *D*, Fig. 1, ahead. This narrowed the slot but left a space between the bevel on the back of the knife and the plane bottom. Shavings collected and clogged in this space and had to be removed after taking only a few strokes. Then he had trouble with the knife. He could not prevent it from chattering, because, "the fellow who made it did not know his business and made it too thin." He threw away the new and perfectly good knife and bought an extra heavy one and then filed away the plane bottom. He did not know that it is necessary to have a support at the back of the knife close to the cutting edge to support and prevent the knife from chattering. A little knowledge of the plane and its uses would have saved him trouble and expense.

It does not matter if a tool is new or old, it is good if it is kept in good order. Some apprentices seem to think that their first requirement is an elaborate tool chest filled with new and expensive tools. They overlook the fact that they are not familiar with tools. They know nothing either of their care or use and they fill up their chest with a collection of instruments, for many of which they will never have any use.

Not long since in company with a patternmaker of some years' experience I passed a second hand shop and saw a display of tools in a large wooden tray near the door. I did not need to ask him to stop and examine them. He soon found three pairs of compasses in good condition excepting that they were worn short and stubby and were rather rusty. He got the three pairs for 60 cents and carried them off. Next day he took them to the shop and had them drawn out and shaped like *A*, *B* and *C*. Fig. 2. A little finishing with file

(*Concluded on page* 795)

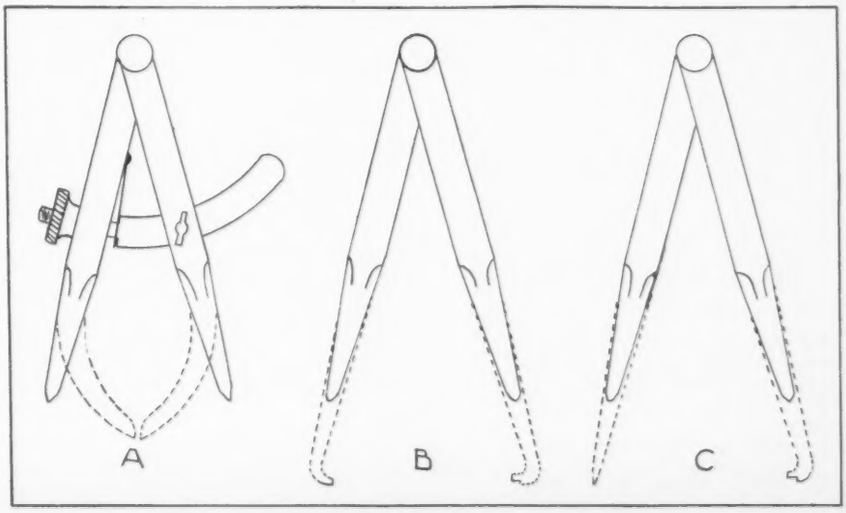



FIG. 2—NEW COMPASSES FOR OLD ONES

# THE FOUNDRY

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## Contents


| | Page |
|---|---|
| Plan Shop with View to Extensions | 757 |
| Effect Consolidation of Equipment Firms | 763 |
| Foundry Exhibitors at London Tool Show | 763 |
| Purchases New Plant | 763 |
| Institution of British Foundrymen | 764 |
| Heat Control in Nonferrous Melting | 766 |
| Oxides in Iron | 767 |
| New Oven Secures Uniform Anneal | 769 |
| Judging Sands for Foundry Use—II | 772 |
| Direct Current Used for Furnace | 775 |
| Self Annealing in Aluminum Bronze | 776 |
| How and Why in Brass Founding | 778 |
| Copper Casting Presents Difficult Problem | 778 |
| Alloy for Razor Backs | 778 |
| Casting Piston Rings in Permanent Molds | 778 |
| Gas Engine Shop Has Many Novel Features | 779 |
| Points on Grinding Iron Castings | 785 |
| Wisconsin Iron Foundry Started | 787 |
| Organizes New Castings Company | 787 |
| Resistance Alloy Patented | 787 |
| Metallurgist Honored | 787 |
| Bill Cogitates on Locomotive Cylinders | 788 |
| Steel Treaters Meet in Philadelphia | 790 |
| Pointers for Pattern Shop Apprentices | 791 |
| Competition Weeds Out Inefficiency | 792 |
| Improved Operation Lowers Costs | 792 |
| Trade Outlook in the Foundry Industry | 793 |
| Comings and Goings of Foundrymen | 794 |
| Pittsburgh Foundrymen Hold Session | 794 |
| New Device Increases Utility of Truck | 795 |
| Floor Stand Grinders | 795 |
| Pointers on Gears | 795 |
| Develop New Car for Charging Malleables | 796 |
| Study Condition of Auto Manufacturing Industry | 796 |
| Conveyor Belt Efficient | 796 |
| Examines Bearing Metal | 796 |
| Chosen to Head Steel-Treating Society | 797 |
| Moves Offices to Detroit | 797 |
| What the Foundries Are Doing | 797 |
| New Trade Publications | 798 |


## Competition Weeds Out Inefficiency

COMPETITION which for some time past has been unknown undoubtedly is hard on the man who cannot operate his foundry efficiently or whose business judgment is not well balanced. Now that the battle for business again is coming back in the foundry industry as well as in other branches of manufacture, the strain incident to operating a plant will increase. It should be remembered that the ultimate result will be a better equilibrium, and a broader and sounder prosperity in the future. During the transition period, if inactivity prevails, the firm with a small fixed expense in capital invested in costly equipment has some advantage over the manufacturer paying interest on a large building equipped with elaborate labor saving devices. Every hour such machinery lies idle means an increase in the rate of overhead which eventually must be carried by the product. In busy times all of this equipment justifies itself without question and it is only when business slumps that the question of its ultimate advantage arises. Much labor saving machinery is so beneficial that even in dull times no doubt arises regarding its worth but such times will test some installations and prove or disprove the wisdom of their installation. A temporary lull never should be permitted to stand as an ultimate test of the value of plant equipment. Time and a trial under varying conditions of long service provides the only fair test and gives the final answer. Before such an answer can be had through actual trial it must be foretold through calculation and vision.

## Improved Operation Lowers Costs

PROGRESS in the foundry industry should not be measured primarily by dividends paid, nor by the tonnage produced, but rather by that knowledge acquired which will aid in the more efficient production of better castings. That branch of the castings business which does not show improvement in its product eventually will fall behind. This has been recognized by the manufacturers of chilled car wheels, the malleable iron foundrymen, and a few others in specialized lines, but the full importance of the principle has not been appreciated by the industry in general. Business came too easy the past few years to offer much incentive to spend money endeavoring to improve castings and lower their costs. However, now that a little slack is appearing in different lines of foundry work, opportunity is offered to give more consideration to a scientific study of processes and products. The large foundry is able to do this better than the small one making only a limited amount of castings. No doubt these more extensive establishments will take the lead and give to the industry in general the benefit of their discoveries. This suggests a field for the consulting metallurgist or the trained investigator. He encounters a problem in one foundry, solves it and when he meets the same difficulty again, he is prepared to attack it with the backing of past experience. Improvement in processes and quality of output encourages the hope that reductions in costs will come in the future mainly through increased efficiency which will benefit alike the foundry owner, the workman and the consumer. Any progress which does not prove advantageous to all of these three branches of industry is not well rounded.

# Trade Outlook in the Foundry Industry

DURING the past two weeks the shift and readjustment in foundry conditions has been most rapid. For a short time previously a decrease in demand in most lines had been noted, and in some directions this even had taken the form of cancellations of existing contracts for castings. Today the cycle has swung entirely around until with few exceptions a buyers' market for castings governs, and some shops are taking on work foreign to that which they have followed for the past two years in order to keep their forces engaged. The trend towards lower prices both in raw materials and manufactured commodities with the aid of better shipping conditions has effected in two weeks time, a change which has been expected for some time.

**Movement Far Reaching**

This reaction, which by most is considered merely a healthful readjustment, extends throughout the country and is not confined to any division of industry. Starting with the automobile companies, where tightening credit and the sudden loosening of material supplies brought the situation to a focus, a slump in buying has brought a lull in business. Competition, which for many months has been shoved into the discard, through the seemingly insatiable demand for all classes of manufactured goods, again has appeared. In the foundry industry, where only two months ago a customer was forced to peddle his patterns from shop to shop in the effort to secure urgently needed castings, the situation is reversed. While many foundries still have sufficient business on their books to keep them in operation until next summer, new orders are exceedingly scarce. In some cases the ability of producers to furnish castings has been aided by easier conditions obtaining in the shipment of raw materials.

**Prices of Raw Materials for Foundry Use**

CORRECTED TO SEPT. 25

| Iron | | Scrap | |
|---|---|---|---|
| No. 2 foundry, valley | $47.00 to 50.00 | Heavy melting steel, Valley | $27.25 to 27.50 |
| No 2 Southern, Birmingham | 42.00 to 45.00 | Heavy melting steel, Pittsburgh | 28.50 to 29.00 |
| No. 2 Foundry, Chicago | 46.00 to 47.00 | Heavy melting steel, Chicago | 24.50 to 25.00 |
| No. 2 Foundry, Philadelphia | 51.25 to 53.50 | Stove plate, Chicago | 32.00 to 32.50 |
| Basic, Valley | 48.50 | No. 1 cast, Chicago | 38.00 to 39.00 |
| Malleable, Chicago | 46.50 | No. 1 cast, Philadelphia | 40.00 to 42.00 |
| Malleable, Buffalo | 51.25 | No. 1 cast, Birmingham | 33.00 to 35.00 |
| **Coke** | | Car wheels, iron, Pittsburgh | 45.00 to 46.00 |
| Connellsville foundry coke | $18.00 to 18.50 | Car wheels, iron, Chicago | 38.50 to 39.00 |
| Wise county foundry coke | 19.00 to 20.00 | Railroad malleable, Chicago | 30.50 to 31.00 |
| | | Agricultural malleable, Chicago | 30.00 to 30.50 |

**Railroads Accelerate**

Better shipments have removed practically all fear of a shortage of raw materials. Foundries literally are flooded with iron and coke, where previously they were obliged to use every means to secure enough to maintain operations. Sand producers also state that they have been able to supply most of their customers with at least 50 per cent of their winter's needs, and that cars are readily obtainable. When the railroads announced on July 1 that a minimum average movement of 30 miles per day for every freight car had been set as their goal, doubt of their ability to reach the mark was expressed. Today, however, many lines report an average in excess of this figure, and this, coupled with the gain through excess loading, has brought railway service far above anything attained in the past three years. The probable effect of this improved operation upon prospective orders for new equipment, and the corresponding effect upon the foundry industry is in question. Many state that improved operation, when taken with the straightened financial condition of the roads, may lead to deferred buying of new locomotives and rolling stock. Up to the present railway buying has had practically no effect upon the foundry industry, although orders for repairs and replacements have kept many railway foundries well supplied with work. Higher rates have not served to bring any advance in foundry raw materials, as this tendency has been more than counteracted by the trend towards lower prices.

**Casting Prices Affected**

With the slackening of demand, a drop in casting prices has resulted in some localities. In Chicago, where the prices for simple gray-iron castings have ranged from 8 to 11 cents, the present level is from 8 to 8½ cents and some are placed as low as 7 cents. In New England, the jobbing shops are the most severely affected by the dropping off in demand. Some shops which during August were forced to turn away work now find that the pressure for delivery has fallen off, and although they have orders on their books little new work is at hand. Some shops handling general machine tool and machinery jobbing work have changed the entire character of their production, and now are making toys, toy parts, paper mill and general construction castings. In lines other than the automotive and machine tool industries, some strengthening has been apparent. Typewriter and electrical appliance shops have been particularly active. In the vicinity of Pittsburgh, foundry operations range from 40 to 75 per cent of capacity. Rolling mill equipment foundries have sufficient work from domestic and foreign sources to keep them occupied until next summer, and railway repair castings have taken up the slack arising from diminished automobile work. In the south, jobbing foundries still find an average inquiry, but cast-iron pipe demand is slow. Throughout the Mississippi valley, a slump obtains with the exception of stove and furnace manufacturing lines. Stove plate foundries report that the present demand is without precedent, and prices recently have been advanced 15 per cent.

Nonferrous foundries, with few exceptions, have felt the reaction. Those supplying parts for electrical devices, sweepers, automobiles, trucks and tractors, are receiving few inquiries. Plumbing brass goods, also, are little in demand and although brass foundry raw materials are at a low point, little interest is evidenced even in scrap. Prices of nonferrous materials, based on New York quotations of Sept. 25 follow: Copper, 17.75c to 18.37½c; lead, 8.00c; Straits tin, 43.50c to 44.00c; antimony, 7.12½c to 7.25c; aluminum, No. 12 alloy, producers price, 34.00c and open market, 27.50c to 28.50c. Zinc is quoted at 7.75c, E. St. Louis.

# Comings and Goings of Foundrymen

MATTHEW RIDDELL who has recently been elected president of the Institution of British Foundrymen is one of the leading foundry experts in the United Kingdom. Mr. Riddell's entire career has been connected with the foundry business in which he has gained distinction entirely through his own efforts without the benefit of any special fundamental educational training. He has occupied responsible positions in foundry circles, chiefly in Scotland, for many years, and is at present head of the castings operations of the Etna Iron Works, Falkirk, Scotland, operated by Watson, Gow & Co., Glasgow. In addition to his business activities, Mr. Riddell has always been unusually interested in the education of apprentices, particularly for foundry work, and it is chiefly through his efforts that an important school for the training of young men in the foundry business has been established at Falkirk, where a research laboratory also is operated dealing with foundry problems.

J. L. Landit has been appointed superintendent of the Buffalo plant of the Semet-Solvay Co., manufacturers of coke and by-products.

James A. Rourke has resigned as president of John Rourke & Sons, Savannah, Ga., iron foundrymen, and has retired from the business.

Otto Gerline, Kalamazoo, Mich., secretary-treasurer of the Gerline Brass Foundry, has purchased the holdings of Samuel Franklin, of Three Rivers, Mich.

Dr. J. M. Johlin, vice president of the Semet-Solvay Co., Syracuse, N. Y., has been elected president of the Syracuse section of the American Chemical society. A. W. Kimman, of the Precision Casting Co., of that city, has been appointed treasurer, and B. Grimes, of the Solvay Process Co., secretary.

Herbert L. James, Catasauqua, Pa., has been elected president of the West Point Foundry Co., West Point, Pa. Llewellyn L. James, also of Catasauqua was elected vice president, and Samuel D. Strauss, of Norristown, Pa., treasurer and general manager.

Nelson Johnson, general manager of the Atlanta, Ga., foundry of the General Fire Extinguisher Co., who is to take care of a new foundry for that company at Warren, O., has been presented with a diamond ring by the employes of the Atlanta shop. Mr. Johnson has been in charge of the Atlanta foundry for the past five years.

Frans H. C. Coppus, president of the Coppus Engineering & Equipment Co., Worcester, Mass., has returned from a summer vacation passed in his old home in Holland.

Maj. Reuben Hill, chief engineer of the Pratt & Whitney Co., Hartford, Conn., has resigned, and has been succeeded by S. Jay Teller, who has been in charge of the pattern department for the company the past year and a half. Mr. Teller formerly was in charge of patent research and supervision work for the Niles-Bement-Pond Co., New York.

MATTHEW RIDDELL
President, Institution of British Foundrymen

J. P. Pero recently has been made general superintendent of the various malleable iron plants operated by the Canadian Car & Foundry Co., Ltd., Montreal. Mr. Pero's experience covers almost 50 years of continuous service in the foundry industry. He resigned the position of general superintendent of the Missouri Malleable Iron Co., East St. Louis, Ill., leaving that company last January after 11 years in charge of the operation of the plant. Mr. Pero was president of the American Foundrymen's association in 1916-1917 and has been a director of that body for a number of years.

## Pittsburgh Foundrymen Hold Session

With an attendance of 75, the Pittsburgh Foundrymen's association held its first regular session of the season at the Hotel Chatham Sep. 20, listened to interesting addresses by C. H. Bierbaum, vice president, and H. P. Parrock of the Luman Bearing Co., Buffalo, N. Y., and Youngstown, O., the former's talk being illustrated with lantern slides. The talk of Mr. Bierbaum related to his work as chairman of the research committee on bearing alloys of the American Society of Mechanical Engineers as it pertained to the manufacture of bronze alloys castings.

In his formal discussion, Mr. Parrock dealt with foundry practice in nonferrous production. The wide variance of output of brass and bronze castings at the Buffalo plant was explained when Mr. Parrock said that during 1918, in the course of the war, it reached 850 pounds a day, while in 1919 it had declined to 650 pounds, and now averages 750 pounds. The spread in production was attributed partly to the character of the work done but chiefly to the morale of the workmen.

Production last year at the Buffalo plant totaled 6,000,000 pounds of castings with an average weight of 2.75 pounds, 250 men being employed.

Electric melting equipment, now being used, was said to have proved satisfactory. At the beginning of the war crucible furnaces were used exclusively. The Detroit electric furnace is being operated on manganese bronze on a basis of 40 to 50 kilowatt hours for the charge and 25 to 30 kilowatt hours on aluminum bronze. The current consumption of a recently installed United States melting furnace was declared to be low.

Dealing with fuel oil, it was stated that experiments with heavy oil have not proved satisfactory and that the best results have been obtained from oil of 45 to 50 degrees baume.

Principal compositions of some 20 varieties of nonferrous alloys were given as follows: Hard metal for

bushings, 80 per cent copper and 20 per cent tin, 82-18 and 84-16 per cent; gears for worm drives, 89 per cent copper, 11 per cent tin; 88 per cent copper, 10 per cent tin, 2 per cent zinc; 80 per cent copper, 10 per cent tin and 10 per cent zinc; for acid-resisting composition, for use in paper mills,86 per cent copper, 12 per cent tin and 2 per cent zinc; manganese bronze, 58 per cent copper, 40 per cent tin and 2 per cent hardener, the latter compromised of practically 1 per cent iron and the other chiefly tin and aluminum.

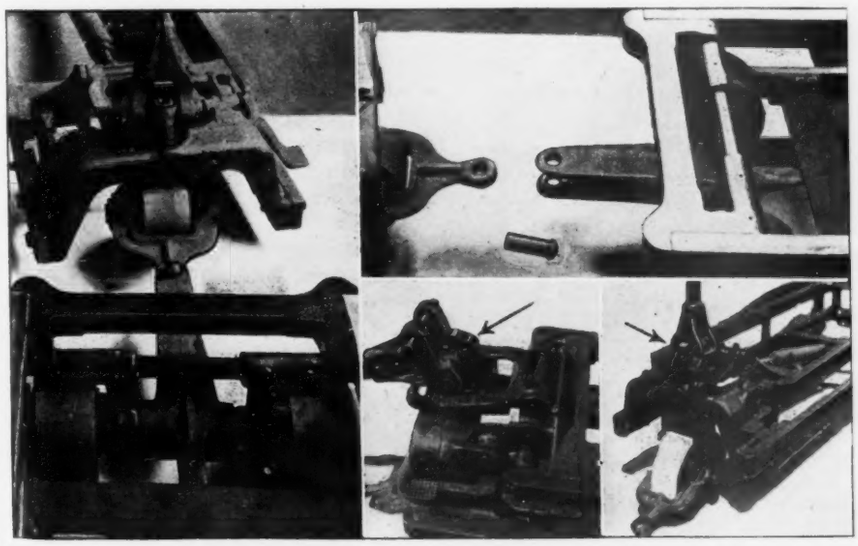
## New Devices Increase Utility of Truck

The attachments shown in the accompanying illustration have been developed by the Cowan Truck Co., Holyoke, Mass., for use with its line of trucks and trailers. The attachment shown at the left of the illustration and in detail at the top right, fits on the front wheel and hitches to the draw bar on the rear axle of the truck or trailer ahead of it.

It involves no change in the construction of the trailer except a longer axle for the front wheel fork. The draw bar is applied to the rear axle of any trailer without even taking off the wheels, as it merely slips over the rear axle. The attachment and draw bar are steel castings.

Combinations of the two parts of this hitch are so made that the shortest possible connection is provided, thus insuring a minimum train length. It is claimed that with this attachment the trucks track almost perfectly and the turning radius is so short that a train of ten has been turned in a circle on a 20-foot roadway. Up and down play is provided for at the joints to prevent binding as the machines go over door sills or over the top of steep inclines.

The latch shown in the lower right hand corner of the illustration has been developed in response to the request of safety engineers for a handie that will not fall down. The latch, made of two leaves of tempered steel spring is attached to the top of the king pin of the front wheel fork. As the handle is thrown back into a vertical position it slips over the spring and it is claimed that no amount of jarring will cause it to fall forward. It does not interfere with the free use of the handle when it is necessary to bring it down.

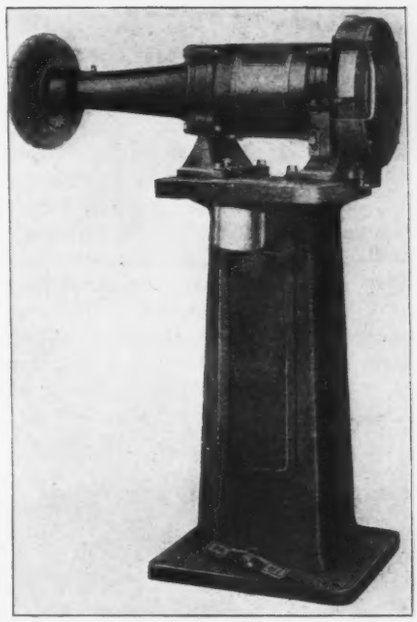


NEW COUPLER AND HANDLE LATCH FOR FOUNDRY TRUCKS

## Floor Stand Grinders

A series of one-horsepower heavy-duty, ball-bearing, electric grinders and buffers is being manufactured by the Van Dorn Electric Tool Co., Cleveland. They are made in several styles, the weight varying from 330 to 525 pounds but the general features are shown in the accompanying illustration. The motors are insulated, tested and rated by standards of the American Institute of Electrical Engineers and are adapted either for direct or alternating current. The diameter of the motor frame is smaller than diameter of wheel, presenting an advantage in design.

The alternating current stator and direct current field assembly are interchangeable in the same frame and easily removed. The pedestal is of substantial design and also serves as a safe and accessible enclosure for the starting and wiring equipment. A centrifugal fan is provided to force air through protected openings at rear of the motor and the wheel housing is provided with a flange to permit attaching to an exhaust pipe should nature of work make it advisable to remove grinding dust. Bearing housings are dust proof with support directly under the bearings.



COMPACT TYPE GRINDER IS FULLY ENCLOSED

Pedestal types are provided with pedal foot switch, fused to meet underwriter's requirements. Direct current machines also are fitted with an automatic starter inside the column to meet underwriter's requirements.

## Pointers on Gears

*Question*—Please tell us what mixture to use for gears, that will range in weight from 25 to 250 pounds each.

*Answer*—A mixture for gears should consist of 10 to 15 per cent steel scrap, 30 to 40 per cent of your own gray-iron scrap and sprues, and the remainder pig iron. The resulting metal should contain 1.75 to 2 per cent silicon, approximately 0.40 per cent phosphorus, 0.50 to 0.90 per cent manganese and the sulphur should be kept below 0.10 per cent.

## Pointers for Pattern Shop Apprentices

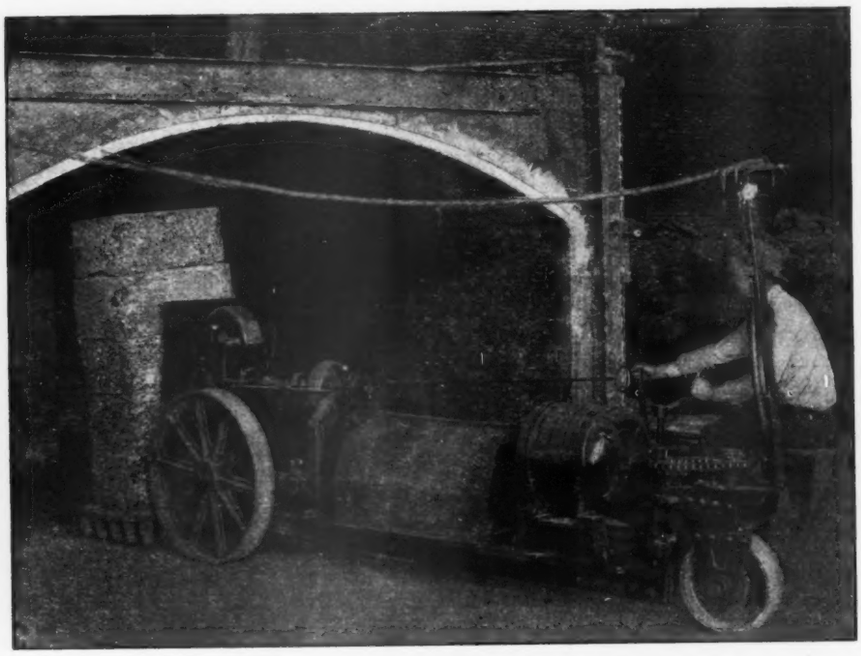
(*Concluded from page* 791.)

and emery cloth produced a set of tools of which any patternmaker need not be ashamed.

An apprentice should not rely on his own judgment, but should have an experienced patternmaker accompanying him when about to purchase tools. Having made his selection, the next most important step should be to learn to hone, grind and keep them in perfect cutting condition. He should learn these things while still an apprentice, and not wait until he is a journeyman.

## Develops New Car for Charging Malleables

The annealing furnace charging truck shown in the accompanying illustration is designed to be operated either by gas engine, air motor or by electric motors taking current from storage batteries or through a trolley. All the trucks are built alike. The different parts are standard and interchangeable. The machine was at first designed to operate with an air motor and still does so in many places but if the owner desires to change over to a gas or electric motor, any part of the compensating gear or the complete gear out of the air truck will fit into the new battery or gas truck. The pot lifting mechanism comprising a worm and gear is enclosed in a dust proof oil bath and is capable of lifting 10,000 pounds.



CHARGING TRUCK IS OPERATED WITH AN AIR OR ELECTRIC MOTOR

The heavily insulated cable carrying current to the truck is shown in the center of the illustration. Where the ceilings are low a retriever is employed to take care of the cable, but with high ceilings this is not necessary. The apparatus is manufactured by J. G. Blum, Toledo, O.

## Study Condition of Auto Manufacturing Industry

A thorough survey of the automotive industry was made by the Motor and Accessory Manufacturers' association during its annual meeting in Cleveland, Oct. 16, 17 and 18. A genera effort on the part of all makers of passenger cars and trucks to attain balanced inventories was reported, and although a decrease in demand for cars was noted, the opinion generally was expressed that a general readjustment would see more favorable conditions.

Optimism concerning the future of the industry was expressed by M. L. Heminaway, of New York, general manager of the association, in a broad review of the automotive industry and the association's achievements. "The automotive industry is not being retarded," he said. "It is merely in a stage of transformation from an oversteady and double-quick time condition to a more sane, steady and stable advance. As long as there is a transportation problem in America and throughout the world, the wheels of the automotive industry cannot be stayed." Mr. Heminway declared it is essential to the industry to consider the fundamental principles of conducting business along sane lines.

The honorary committee of the association in charge of the convention included: Chairman C. E. Thompson, president of the Steel Products Co., Cleveland; E. W. Beach, general manager of the Ferro Machine & Foundry Co., Cleveland; Claude Foster, general manager of the Gabriel Mfg. Co., Cleveland, and C. W. Hotchkiss, manager of the National Malleable Castings Co., Cleveland.

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Dwight P. Robinson & Co., Inc., recently have established a branch office in Youngstown in charge of C. I. Crippen.

## Conveyor Belt Efficient

An unusual problem in the handling of hot cement clinker having a temperature of 200 degrees or more was recently solved at the plant of the Standard Portland Cement Co., Leeds, Ala. A rubber conveyor belt was installed for the purpose and to prevent the hot clinker from scorching the fabric the belt was run at an incline of 12 degrees from the horizontal. The lower pulley was partly submerged in a tub of water and as a result the belt was always protected with a film of cold water.

A special belt fastener was employed which brought the ends of the belt snugly together. It rendered the belt practically endless on the pulley side; prevented clinker ash from getting in the joint where it would abrade the belt ends and as no metal came into contact with the pulleys to cause wear, a permanent joint was assured.

In six months' operation the belt has carried 61,000 tons of clinker at an estimated saving in belt cost of $300. The belt used which is made by a prominent company particularly to withstand high temperatures up to 200 degrees Fahr., is adapted for work on conveying jobs in mines, coking plants and cement factories where heat resistance and ability to withstand hard wear are prime requisites.

## Examines Bearing Metal

The tests at elevated temperatures of babbitt bearing metals, four of which were investigated in connection with the Society of Automotive Engineers' specifications for such material, have been completed by the United States bureau of standards. The yield point and ultimate strength decreased rapidly with increasing temperature. It would appear that babbitts containing lead lose their strength more rapidly than those with a tin base. Brinell hardness measurements also have been made on these four samples, and will be repeated later on larger specimens. In order to study the effect of small quantities of lead on the physical properties of a high-grade, tin-base babbitt, varying percentages of lead have been added to metal made in accordance with specification No. 2 of the American Society for Testing Materials, and the physical properties of the various combinations thus secured will be studied at ordinary and at elevated temperatures. A thermostatically-controlled oil bath has been constructed for annealing specimens, over long periods of time in order to determine its effect on the mechanical properties of the babbitts.

## Chosen to Head Steel-Treating Society

Albert E. White professor of chemical engineering at the University of Michigan, was elected president of the American Society for Steel Treating which was organized at Philadelphia on Sept. 14 by the amalgamation of the Steel Treating Research society and the American Steel Treater's Society.

Dr. White is one of the foremost chemical engineers in the country and is head of the department of chemical engineering and industrial bureau at the university. During the war he entered the ordnance department of the United States army as a captain and was promoted to be a lieutenant colonel. He served as chief of the research section, associate chief of the nitrates division and consulting chemical engineer of the department.

ALBERT E. WHITE

In his professional capacity he visited nearly all the important steel casting plants in the eastehn half of the United States in 1916 and 1917. He had under his supervision the inspection of all steel casting plants producing ordinance material for the United States army from January, 1918, until he left the service in March, 1919. Some of the conclusions he arrived at as a result of his ordnance inspection experience were submitted in a paper presented at the Philadelphia convention of the American Foundrymen's association Sept. 29-Oct. 3.

Professor White is a member of the American Chemical society, American Society of Testing Materials and American Institute of Chemical Engineers. He is the author of *Technical Gas and Fuel Analysis.*

## Moves Offices to Detroit

The American Malleables Co. with plants at Lancaster, New York and Owosso, Mich., has removed its general office from its Lancaster plant to the Kresge Bldg., Detroit. P. G. Smith, vice president of the company will have charge in the latter city.

Ernest Creher, president of the Tampa Shipbuilding & Engineering Co., Tampa, Fla., has purchased 40 acres of land in Tarrant City, Ala., near Birmingham, and it is reported that he will construct a foundry and machine shop or possibly a steel fabricating plant.

# What the Foundries Are Doing

### Activities of the Iron Steel and Brass Shops

The stove foundry of Steiger & Keer, San Francisco, recently was damaged by fire.

The Rogers Foundry Co., Joplin, Mo., has opened a malleable iron foundry at Baxter Springs, Kans.

The American Foundry & Construction Co., Pittsburgh, plants the erection of an addition to its plant.

The plant of the Eric Lindgren Foundry, Batavia, Ill., recently was damaged by fire.

The Kovay Foundry Co., Chicago, is completing the erection of a foundry building.

The Elyria Brass & Bronze Co., Elyria, O., has started work on the erection of a new plant.

Plans are being prepared for the erection of a foundry, 50 x 175 feet, at Delaware, O., for the Delaware Brass Foundry.

The Price Evans Foundry Co., Chattanooga, Tenn., contemplates the erection of a plant building, 45 x 60 feet.

The Walsh & Weirner Boiler Co., Chattanooga, Tenn., plans the erection of a foundry, 80 x 180 feet.

The Unit Stove Works, North Birmingham, Ala., is reported planning the erection of an addition to its plant

The foundry at the plant of the National Steel Products Co., Bessemer, Ala., recently was damaged by fire.

The Penobscot Foundry Co., Bangor, Me., plans the erection of a machine shop, 2-stories, 50 x 100 feet.

The Walker & Pratt Co., 33 Union street, Boston, plans the erection of a foundry, 200 x 230 feet.

The Fay Foundry Corp., Syracuse, N. Y., has been incorporated with a capital stock of $50,000, by James J. Fay, Dennis R. McCarthy and others.

Modern appliances will be installed in a new foundry which the Production Machine Co., Greenfield, Mass., is erecting as an addition to its plant.

The West Point Foundry Co., West Point, Pa., has been incorporated with a capital stock of $30,000 by S. B. Strauss and others.

The International Brass & Copper Co., Newark, N. J., has been incorporated by Irving Eisenberg, M. A. Potter and E. T. Adams.

The Baltimore Malleable Iron & Steel Castings Co., Baltimore, plans the erection of an extension to its plant.

The Gerhart Brass Foundry, 1301 Fidelity building, Baltimore, has been organized by George B. Gerhart, John D. Nock and others.

The St. Johns Industrial Foundry, St. Johns, Mich., plans the erection of an addition to its plant, 50 x 140 feet.

The New England Foundry Supply Co., Hartford, Conn., recently was incorporated with a capital stock of $50,000, by W. W. Burroughs and others.

The Rex Metal Pattern & Machine Co., New York, has been organized by E. G. Grainlund and H. Heller, 444 West Thirteenth street, New York.

Ground has been broken for the erection of additions to the plant of the Akron Rubber Mold & Machine Co., Akron, O.

Contracts have been let by the Springfield Foundry Co., Springfield, Mass., for the erection of a boiler house.

Plans are being prepared by the John J. Riley Co., Brooklyn, N. Y., for the erection of a foundry, 100 x 250 feet.

Capitalized at $25,000, the Globe Brass Foundry Co., Brooklyn, N. Y., recently was incorporated by J. A. Keesey, J. F. Dixon and E. Fiamma.

The Bridgeport & Norofik Brass Corp., Bridgeport, Conn., recently was incorporated with a capital stock of $100,000, by Samuel Luciano, Westport, Conn., William Blake and others.

The Globe Malleable Iron & Steel Co., Syracuse, N. Y., plans the erection of a machine and forge shop, 39 x 62 x 102 feet.

The Termaat-Monahan Mfg. Co., Oshkosh, Wis., has completed the erection of several plant additions, including a foundry addition, 50 x 100 feet.

The Burnside Steel Co., 1300 East Ninety-second street, Chicago, is erecting a pattern shop and office building, 1-story, 40 x 100 feet.

Lavine Faust, the Mechanics Machine Co., Rockford, Ill., is reported planning the erection of a modern foundry building.

The Griffith Foundry Co., 502 Oakley avenue, Griffith, Ind., contemplates the erection of a malleable foundry, 90 x 225 feet.

The Great Western Stove Co., Choctaw and Second streets, Leavenworth, Kans., contemplates the erection of a plant.

Erection of an addition to its plant, 50 x 50 feet has been started by the Regent Stove Co., Wyandotte, Mich.

Capitalized at $40,000, the Rochester Foundry & Machine Co., York, Me., recently was incorporated by Harry Winebau, Abraham Shapiro and Aaron B. Cole.

The Federal Foundry Co., Inc., Waterbury, Conn., recently was incorporated with a capital stock of $15,000, by Sol Sossin, G. J. Archambault and W. R. Avery.

The Erie Gray Iron Co., Erie, Pa., recently was incorporated with a capital stock of $50,000, by T. M. Light, J. J. and W. J. Hannon and D. Struebel.

The East Penn Foundry Co., Macungie, Pa., has started on preliminary work on its new foundry. Additional equipment will be installed.

Capitalized at $125,000, the Zenits Foundry Co. Detroit, recently was incorporated by Stanley Leech, 746 Atkinson avenue, and others, to manufacture iron, brass, aluminum and other castings.

The Peeler-Hansen Stove & Foundry Co., El Paso, Tex., recently was incorporated with a capital stock of $12,500, by L. J. Peeler, H. N. Hansen and H. M. Andreas.

The Dominion Motor Castings, Ltd., Windsor, Ont., recently was incorporated with a capital stock of $250,000, by Clifford A. Ripley, Frederick Skellenger and Adolph Janda.

The American Furnace & Foundry Co., Milan, Mich., is preparing to begin production in its new plant. E. L. Watson is president. It is said the company has orders aggregating $500,000.

Additions now under way for the Consolidated Utilities Corp., Binghamton, N. Y., include several additions to its foundry, 30 x 45 feet, 20 x 30 feet, 25 x 40 feet and 20 x 30 feet.

The Andes Foundry Co., Ephrata, Pa., recently was incorporated with a capital stock of $25,000, by Eugene B. Andes, M. E. Andes and William D. Andes, Lancaster, Pa.

The Automotive Castings Co., Detroit, has been organized with a capital stock of $50,000 by Arthur J. Kies, John D. Cronenweth and W. J. Mahlitner.

The Wood-Embly Brass Co., Waynesboro, Pa., has been incorporated with a capital stock of $25,000, by D. E. Kauffman, Robert A. Wood, John J. Schmidt and J. L. McCleary.

Contracts have been awarded by the Peerless Foundry Co., 5602 Baum boulevard, Pittsburgh, for the erection of an addition to its plant, 50 x 120 feet.

The Baltimore Malleable Iron & Steel Castings Co., Baltimore, which recently was purchased by the Kennedy Corp., will make improvements to its plant.

Erection of an addition to its steel foundry, 166 x 180 feet, has been started by the National Brake & Electric Co., Milwaukee, P. E. Tell is president.

Contracts have been let by the Milwaukee Gray Iron Foundry Co., Milwaukee, which recently was incorporated with a capital stock of $75,000, for the erection of the first unit of its proposed plant.

The La Point Foundry Co., Schleishingerville, Wis., has changed its name to the Rex Foundry Co., and is increasing its output by the purchase of the fomer shop of the Vim Tractor Co., which is 50 x 275 feet. Inquiry is being made for additional casting and molding equipment, etc.

The Haskell & Barker Car Co., Michigan City, Ind., is having plans prepared by Frank D. Chase, Inc., Chicago, for the erection of a foundry building.

The Phoenix Foundry Co., Burlington, Iowa, of which W. T. Chambers is president, is building a plant for the production of brass, bronze and aluminum castings.

The Industrial Equipment Co., Montreal, Que., recently was incorporated to manufacture foundry supplies, etc., with a capital stock of $20,000, by Joseph J. Harold, D. Burley-Smith and others.

The Vassar Foundry Co., Vassar, Mich., is completing the erection of its second manufacturing unit 92 x 200 feet. The plant now has a capacity for 30 tons a day of motor castings. The company is capitalized at $100,000. J. C. Green is president.

Ernest Creher, president of the Tampa Shipbuilding & Engineering Co., Tampa, Fla., has purchased 40 acres at Tarrant City, Ala., and it is reported he will construct a foundry and machine shop, or a steel fabricating plant.

The capital stock of the Colonial Foundry Co., Louisville, O., recently was increased from $65,000 to $250,000, and it is expected the company will shortly commence the erection of a number of plant additions.

Articles of incorporation have been filed by the Star Foundry Co., Evansville, Ind., with a capital stock of $150,000. The company will manufacture iron and copper castings. Organizers are Edward Klechle, F. L. Stoltz and William J. Abigt.

The Mace Co., Milwaukee, recently was organized to manufacture and deal in foundry supplies, etc., with a capital stock of $25,000, by Robert L. Peters, C. C. Thieme, and Charles E. Hammersley, 714 Majestic building, Milwaukee.

The Fremont Casting Co., Worcester, Mass., recently was incorporated to operate a foundry, with a capital stock of $50,000, by Edwin H. Marble, Charles F. Marble and Albert C. Marble, all officers of the Curtis & Marble Machine Co., Harry A. Wilber and Herbert A. Davis, Torrington, Conn.

Under the leadership of P. M. Kettenhofen, formerly of the Beaver Dam Malleable Range Co., Beaver Dam, Wis., the Cedar Grove Stove Co. has been incorporated with a capital stock of $100,000, and will take over the plant of the Wisconsin Foundry & Steel Works at Cedar Grove, Wis.

The Chattanooga Implement Co., Chattanooga, Tenn., manufacturer of agricultural implements, will build an addition to its foundry building. It is expected the addition will increase the capacity of the plant about one-third. The company recently completed the erection of an addition to its pattern shop.

Organized by William J. Muhlitner, who for six years was identified with the Detroit Foundry Co., Detroit, but who since 1915 has been secretary and manager of the Foundry & Machine Products Co., Detroit, the Automotive Castings Co. has purchased the plant and business of the Merrill Mfg. Co., Inc., Imlay City, Mich. The plant produces gray iron castings.

The Chain Belt Co., Milwaukee, has acquired 30 acres giving it a site of approximately 60 acres for its new works. Construction of the new plant was started a year ago, the new concrete mixer plant being completed in the spring, and two other structures are now nearing completion. One is a malleable foundry and the other a 3-story core building.

Continuing to manufacture andirons, shoe lasts, anvils and gray iron castings, the Interstate Foundry Co., Anniston, Ala., has added six floors to its building for the manufacture of cast iron soil pipe and fittings. The capacity of the plant has been trebled during the past two months and the working force has been increased to 100. Officers of the company are: President, G. G. Britton; vice president and general manager, Alma Quinn and secretary and treasurer, Frank Leigh.

# New Trade Publications

STEEL SHELVING.—Adjustable steel shelving is described and illustrated in a folder being circulated by the National Scale Co., Chicopee Falls, Mass.

BONDING MATERIAL.—Refractory plastic material for bonding firebrick and kindred uses, is described and illustrated in a booklet being circulated by the Quigley Furnace Specialties Co., New York.

CHARGING EQUIPMENT.—The Cutler-Hammer Mfg. Co., Milwaukee, has published a 24-page illustrated bulletin in which battery charging equipment for electric street vehicles, industrial trucks, battery locomotives, etc., is described and illustrated.

CALLING SYSTEM.—The National Scale Co., Chicopee Falls, Mass., is distributing a booklet in which an electric calling system, for use in large industrial plants, stores, offices, etc., is described and illustrated.

INSULATING FABRICS.—A 12-page illustrated booklet has been published by the General Electric Co., Schenectady, N. Y., in which insulating fabrics, used by the company in the manufacture of its various products, are described and illustrated.

WIRE ROPE SLINGS.—A catalog containing the latest information on various types of wire rope slings for use in shops and the field in the handling of heavy loads, has been published by John A. Roebling's Sons Co., Trenton, N. J. The book is profusely illustrated showing the use of wire slings.

ELEVATING TRUCKS.—The National Scale Co., Chicopee Falls, Mass., has published an illustrated booklet in which elevating trucks are described and illustrated. These trucks can be raised from the front or either side, facilitating loading in congested and narrow aisles.

METAL PARTITIONS.—The R. F. Carpenter Mfg. Co., Cleveland, is circulating a 24-page illutrated booklet in which metal partition for toilets, showers, urinals, etc., as well as interior steel dividing partitions for offices and factories and gravity rollers, hinges and toilet room hardware, are described and illustrated.

COUNTING MACHINES.—Twenty-six types of counting machines are described and illustrated in a booklet being circulated by the National Scale Co., Chicopee Falls, Mass. According to the booklet, these machines give an accurate and quick count of any commodity, consisting of similar parts or pieces, without the use of tabulated figures of weights, mental calculation or figuring of any kind.

ELECTRIC FURNACES.—The Booth Electric Furnace Co., Chicago, is circulating an illustrated booklet in which rotating electric furnaces are described and illustrated. Among the illustrations are a number of line drawings, which show in detail the principles of the furnace construction, in these drum-type electric arc furnaces. Complete data are given, including specifications.

INSULATING COMPOUNDS.—The General Electric Co., Schenectady, N. Y., is circulating a 16-page illustrated bulletin in which various insulating compounds, such as insulating varnishes, japans, oils, stickers and shellacs, paints, etc., used by the company in the manufacture of its various products, are described. The booklet is interesting and the uses of the compounds which are cited, should serve as a guide in the selection of those to meet similar service.

ELECTRIC GRINDERS.—The Van Dorn Electric Tool Co., Cleveland, has issued a bulletin in which pedestal bench grinders are described. According to the bulletin, these grinders are tested and rated by standards of the American Institute of Electrical Engineers, and have ample power to drive 10-inch x 1½-inch wheels without stalling. The motor will not exceed a temperature rise of 55 degrees in 30 minutes at 1½ horsepower load. Additional details are given.

ADJUSTABLE SPEED MOTORS.—A bulletin describing direct current adjustable speed motors has been published by the General Electric Co., Schenectady, N. Y. In these motors, according to the bulletin, compensating winding practically eliminates flux distortion losses and to prevent field distortion the compensating winding is distributed instead of being concentrated at the commutating pole faces. For ordinary service, driving shapers, slotters, lathes, etc., a simple drum controller can be used. Current peaks are limited. Other details are given.

FOUNDRY SUPPLIES.—Putting a party dress on a fairly prosaic subject, dealing with wheelbarrows, trucks and flasks, the Sterling Wheelbarrow Co., Milwaukee, has issued a handsome catalog of slightly over 100 pages. Fine paper, high grade art work and color are employed to carry the message of the Sterling products and a distinct feeling of class is awakened by the pages. Details of the rolled steel flask that give it value are set forth by numerous illustrations and clear text. Flask pins and bars, many types of barrows for foundry and core room, foundry trucks, ladle buggies, carts, slag buggies and a complete line of foundry specialties from gate stocks to upsets occupy the remainder of the pages. The whole is encased in heavy paper covers embossed with a striking design and inside the back cover is a convenient pocket to hold the price list and discount sheet.